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SCIENCE

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SOME REFORMS NEEDED IN THE TEACHING OF PHYSICS[1]

Last year's decision of the council of the American Association shows clearly the desirability of distinguishing between the work of the various sections and that of the more technical, scientific societies which meet in conjunction with the association. By leaving the presentation of special papers on research topics to the American Physical Society our section will in future pay more attention than heretofore to the discussion of general topics and by joint sessions with other sections strengthen the, in recent years, somewhat neglected ties between physics and allied sciences. There is an abundance of general subjects from which to choose.

For example, during the past few years a renewed interest has been shown, especially by high school teachers, in the teaching of physics—leading in the course of events to the so-called "new movement among physics teachers," new only in so far as it is an organized effort to improve the teaching of the subject in the high schools.

Your speaker has followed this movement with great interest, hoping that some definite reform might be accomplished by it; but it must be admitted that, as far as actual improvements in those high schools, where such improvements are most needed, are concerned, the progress has been very, very slow. The strongest censure which

[1] Address of the vice-president and chairman of Section B—Physics. American Association for the Advancement of Science, Boston, 1909.

can be made is that, while there is no lack of criticism in a general form, as: "The course is too mathematical," or "The course contains too many topics" no clear-cut, definite proposition for reform has yet been made. For example, we have waited in vain for an answer to the question: "Which mathematical relation should be omitted?" or, "Which topics seem superfluous?" Most of the better high school teachers have not changed their course. Why should they do so? We have statistical data showing that over 90 per cent. of the students in the larger Michigan high schools, after having taken physics, which is a required study, declare that they would elect the subject if allowed free choice. But doubtless statistics could also be produced showing the opposite effect upon students in other schools and under other teachers.

There has been considerable hesitancy on the part of the college professor to interest himself in this question; but within the last year or two a change has taken place, and it is a hopeful sign that section B is to have a discussion on educational problems during this week. Let us hope that some positive results may be reached. The decision as to how physics should be taught rests finally with those men who know the subject, understand the spirit of our science and for this reason are the only judges of its characteristic educational value. Leaving the discussion of the teaching of physics in our high schools to our session on Friday, I wish to speak upon a subject seldom touched upon in our former discussions: "The Teaching of Physics in our Colleges and Universities."

Many of us have heard the amusing remark: "The worst teacher is the college professor," a remark which always meets with the hearty approval of unripe high school teachers and arouses an unfortunate antagonism, instead of leading to a helpful cooperation between college and high school men. No matter how much importance we attribute to the new movement or to such a sweeping statement as the one just mentioned, may not we college professors in the end be held responsible for the conditions in the high schools? Or to be specific: "May not the preparation which we give future teachers be faulty?" and "May not our own teaching be capable of improvement?" I believe both these questions should be answered in the affirmative.

1. My first proposition is then: The system of the teaching of physics in many of our colleges and universities is more adapted to train professional physicists than future high school teachers. I take for granted that the two should receive a different training, a statement with which many of you will doubtless not agree. For my own part, I believe that the ideal high school teacher is one who has passed through a complete and thorough graduate course. However, we are not talking about ideals, but about conditions which actually confront us. At the present time the great majority of our high school teachers do not go beyond graduation, and I would deplore any attempt to crowd so much physics into the undergraduate course, that the physicist whom we may finally turn out lacks the general culture which an undergraduate course should give. We can hardly demand that an undergraduate spend more than from 20 to 24 semester hours in the department of physics, even if he expects to teach the subject in the high school.

In many of our institutions an elementary course is given, requiring the knowledge of very little mathematics. After passing this the student is turned loose on advanced studies, often highly specialized mathematical courses. By the time of graduation he will have lost a general

grasp of the subject which he might have had before, but probably never acquired.

We should emphasize more problem work in connection with the elementary course. An utter helplessness of many higher classmen in attacking elementary problems is not unusual. The laboratory work given with the elementary course is frequently quite insufficient, and a somewhat advanced course, not in special lines, but covering the whole field, will do an untold amount of good. Finally there should be a general review of the whole subject from a higher point of view than is possible in the elementary course. Calculus might be a required study for this. At this point subjects might be taken up which have been omitted in the first course, the treatment could be more thorough and more exact. I believe that the introduction of such an advanced course would also have a good influence upon the first course. Now we feel too much under an obligation to present as large an amount of information as can be crowded into two semesters. If we know that those who are interested in our science can obtain a knowledge of the less common phenomena later on, these might be omitted at first and the elementary course could be made more thorough in what it teaches. Several text-books on university physics contain so much material and a good deal of it presented from such an advanced point of view, that they can not be covered the first year. The more difficult topics might well be reserved for such a course as I propose. Finally, every teacher of physics should be acquainted with the history of his science. The gross ignorance among some physics teachers of the development of physical theories and of the work of the intellectual giants, to whom mankind is indebted for its present civilization, is appalling.

A course of study, as outlined, would not require more than 24 semester hours. I might add that, where time allows, I would advise future physics teachers to take also a course in meteorology, a short course in dynamo-electric machinery and an elementary course in instrument-making, all of which might properly be given in the physics department. It is my firm belief that such a graded course will produce teachers to whom we may leave without hesitancy the question as to how physics should be taught in the high school. I have nothing to say about those people whom an incompetent school board appoints, though they had never more than a one-year's elementary training. We university teachers can certainly not be held responsible for their failure. What a pity that we can not prevent such men and women from experimenting upon our children.

It is a hopeful sign that from year to year a larger number of students stay with us after graduation or return during summer school to pursue graduate studies. It shows a slowly growing recognition of the fact that teaching is a profession and that professional knowledge in the chosen line of work is necessary even for high school teachers. Such knowledge can only be acquired by graduate work in this line, *i. e.*, in our case, in physics. An undergraduate course, as outlined above, is certainly not antagonistic to this spirit; yes, may it not raise the standard of our graduate work?

I am fully aware of an objection to my scheme and appreciate its force. You may ask: "Do you wish to prevent the professor in the small college, where the main object is to train teachers, from giving any graduate work?" I must admit, though very reluctantly, that such is the case, provided that the college in question is unable to furnish a sufficiently large instructional staff. If it is a question between one or two graduate courses and a

general review course, I believe the latter should be given. While it may be more interesting and profitable for the professor to teach the advanced subjects, he should subordinate his personal wishes to the efficiency of the college. If he be fortunate enough to discover an exceptional man, is it not best for the latter to go to an institution affording larger facilities for his future work, to an institution where close contact with a number of investigators will stimulate and inspire him? Such a student will always remain loyal to his old college professor and be proud of being a graduate of an institution which has given him a thorough fundamental training.

2. As was suggested in the earlier part of the paper, not alone the college curriculum of the future high school teacher is being criticized, but also our teaching. We must admit that there is and always will be room for reform. The best we can do is to apply remedies after we have been shown clearly just where the trouble lies. In education we should not apply patent medicine, invented to cure general debility. Therefore we will not talk about methods. It would be an unfortunate condition, ending in stagnation, were all university professors forced to teach according to certain pedagogical rules which suppress individuality and kill spontaneous enthusiasm.

I shall be specific and state my second proposition thus: "We are far from being unanimous in the use of certain terms and frequently employ the same term to designate two entirely different physical quantities." This means that we do not pay enough attention to the very things which make physics so valuable as a training of the mind, namely, clearness of thinking and accuracy of expression.

Let me cite the most flagrant cases:

a. What is pressure? In every-day usage it is a force, pure and simple, as illustrated by the classic problem: How large a pressure is exerted upon a vertical wall by a beam leaning against it? Leaving this interpretation entirely out of consideration, is pressure the force, acting upon unit area, or, the force per unit area, *i. e.,* a force divided by an area? In other words: Has pressure the dimensions of a force or not? Both definitions are doubtless taught, but if we assume the former to be correct, then in our formula

$$F = PA$$

A does not represent an area, but the *number* of units of area upon which the force acts. Of course I assume that P stands for pressure.

But if we do this, we get into trouble when we discuss the work done upon or by a gas. For in the equation

$$W = PV$$

the V would no longer represent a volume, but a length. In fact, as soon as we speak of the action of a gas, we discard the force and substitute for it the abstract concept of the proportionality factor P between force and area. This abstract idea, which most of us call pressure, is nevertheless a real physical quantity.

I believe the greatest difficulty to the beginner in physics arises at the very moment when he is confronted with such an abstract physical quantity, *e. g.,* acceleration. He feels suddenly the solid ground slipping away from under his feet and regains confidence only after he has manipulated this quantity again and again in the solution of problems. So it is with pressure; we can not blame the student for trying to hold on to his old friend, the force, as long as he possibly can.

Clifford says: "When that which we do not know how to deal with is described as made up of things we do know how to deal with, we have that sense of increased power which is the basis of all higher

pleasures." We should keep this always in mind in the presentation of our subject, but should not go so far in our wish to arouse this higher pleasure in the student as to make incorrect statements as the one that the pressure coefficient P is a force, and the other quantity A in our first equation an area. Let us be consistent and use the term "pressure" only for one physical quantity, and not for two or even three. In modern education we find too much a tendency to introduce kindergarten methods in the high schools; keep them out of the college.

b. In surface-tension phenomena we have a very similar case, since the force is expressed here by the equation

$$F = Tl.$$

The capillary constant T is usually called "surface tension," but we may read in the same book which gives this definition, that the weight of a liquid is balanced by the surface tension. The latter statement, though consistent with ordinary usage, does not agree with the former definition. All the preceding arguments in favor of accuracy and uniformity in our teaching apply in this case.

It is true, it is a hard task to teach students a new meaning of a word which they have been in the habit of using in a different, or at least in a much broader sense. But are we not successful in making them distinguish between mass and weight, though the same difficulty arises in this case? It is well known that the importance of the law of conservation of energy was not fully appreciated, until the new term "energy" with its definite present physical meaning was introduced and we stopped talking about the conservation of force.

c. In the chapter on Heat we find several inconsistencies. Every physicist knows perfectly well that the term "absolute temperature" refers to temperature measured on the thermodynamic scale. Nevertheless, we call the zero of the constant volume hydrogen thermometer the absolute zero and we call temperatures, measured from this point and by this thermometer, absolute temperatures. We even refer to any gas thermometer, no matter whether of constant volume or constant pressure, in defining absolute temperature. There seems to be no other remedy but to invent a new name, a tempting task for a philologically inclined physicist. Do not let us make light of our trouble because these different temperature scales agree so very closely. They are different. A man has not discovered the north pole even if he came within a few miles of it.

d. Another example occurs in the common expression of quantity of heat as

$$H = cM(t_2 - t_1).$$

The factor c is usually called "specific heat." It is really the "heat capacity of the substance" in question and is taken as unity for water under standard conditions. But it is not a pure number. It has definite dimensions, while "specific heat," defined as the ratio of the heat capacity of the substance to that of water, *is* a pure number; in other words, the relation between these two thermal quantities is exactly similar to that between density and specific gravity. We distinguish very carefully between the latter two, even where the numerical value would be the same.

This numerical equality has done more than anything else to befog our minds about the true nature of a physical quantity. Next in importance comes our inheritance of terms from old, long discarded theories. Think of such terms as "specific heat" which is not heat at all, or "electromotive force" which is no

force. A discussion of all misfitting names would, however, lead us too far from the subject under consideration.

e. Though I do not wish to tire you by an enumeration of all examples of inconsistency in our teaching, I can not pass by in silence a case where our lack of accuracy introduces the most serious difficulties. It is the indiscriminate use of "lines of force," not alone for "lines of intensity," but also for "lines of induction." These two are very different things, as well in electrostatics as in magnetism, and neither the intensity nor induction is a force.

Let us consider a magnet and the field surrounding it. According to the old theory of action at a distance there is no magnetic disturbance anywhere in the space about the magnet, until we introduce a magnetic pole. Then, it is true, we have a force between magnet and pole. But this theory has long been overthrown. We know now that at every point of a magnetic field there exists a certain disturbance, call it a stress, if you please, whose magnitude and direction are given by the intensity of the field at that point. Moreover, the intensity of the magnetic field has nothing to do with a force, except that we may *measure* it by the force acting on pole strength m according to the equation, defining intensity H

$$F = Hm.$$

It is usually stated that the lines of force show the direction of the intensity, and their number through unit area, drawn at right angles to the direction, represents the magnitude of the intensity.

The use of a misleading name is not my main objection. The trouble begins at this point. After having used lines of force as synonymous with lines of intensity, it is serenely asserted that the cutting of lines of force produces an induced electromotive force in a conductor. You know that the magnitude of this electromotive force does not depend upon the intensity, but upon the rate with which the lines of induction are cut.

Only very few text-books give the correct expression for the induced electromotive force as

$$E = Blv.$$

To write H instead of B in this formula is radically wrong. The *numerical* value of E will be correct, provided the medium is air. The dimensional formulæ for the left and right hand sides of the equation balance only if we use B. Every experiment in electromagnetic induction is an example of the correctness of this statement. We all teach that the intensity of the field is analogous to a stress, the induction to a strain in an elastic medium, both being connected by the equation

$$B = \mu H.$$

No one would tolerate such a confusion of stress and strain in mechanics.

The historical development of lines of force is very interesting and explains to a certain extent the origin of our troubles. Faraday introduced the lines of force, but not in the sense of lines of intensity. Many quotations from his writings might be given, all showing that he meant by lines of force what I have called lines of induction. For example he says:[1]

> I have not referred in the foregoing considerations to the view I have recently supported by experimental evidence that the lines of force, considered simply as representants of the magnetic power, are closed curves, passing in one part of their course through the magnet and in the other part through the space about it. *These lines are identical in their nature, qualities and amount, both within the magnet and without.*

It is true, Faraday also speaks of lines in connection with field intensity, but here he uses various terms. Thus he writes:[2]

[1] Faraday, "Researches," Vol. III., p. 417.

[2] "Researches," Vol. I., p. 411.

I have used the phrases *lines of inductive force* and *curved lines* of force in a general sense only, just as we speak of lines of magnetic force.

He does not represent field intensity by lines.

Maxwell, however, changed the meaning by calling Faraday's lines of force lines of induction and using the term lines of force for lines of intensity only.

And we? We use the words sometimes in Faraday's sense, sometimes in Maxwell's sense. We introduce them when speaking of field intensity and later on make the glaring mistake of asserting that the induced electromotive force is measured by the cutting of lines of force. The American Institute of Electrical Engineers has proposed to call the unit of magnetic intensity the "gauss"; it seems to be a general understanding, judging from papers appearing on magnetic subjects, that it is also the unit of induction. Personally I prefer to discard the troublesome term altogether, but it may be that it has become so familiar to the scientist and is so generally used in engineering practise, though usually there in the meaning of lines of induction, that it is too late to abolish it altogether. If we must keep the lines of force in our text-books, let us use them in one sense only. We should certainly stop confusing our students about the real nature of these two totally different quantities.[8]

I hope to have proven that we lack in the presentation of several topics that accuracy of expression of which in general the physicist can be justly so proud, and that greater uniformity in the use of certain terms is very desirable. Our ideas as to the fitness of proposed names for the quantities in question as well as to the choice of definitions, may be widely different. Your speaker clearly realizes that there is ample room for discussion and that the sporadic attempt of a single scientist to correct the apparent faults in our teaching can not better the conditions appreciably.

[8] See also a paper by Professor Patterson, "Michigan Technic," 20, No. 2, p. 35, 1907.

Reforms of a lasting nature can be accomplished and the desired result reached in shortest time, only, if definite propositions be made by a committee consisting of a number of representative physicists. With their influence behind a reform movement of this kind we shall soon reach practical unanimity.

In conclusion, let me assure you from my own experience that it is not an extremely difficult matter to teach the student to make these fine distinctions between different physical quantities. It is true, it requires some deep and accurate thinking; but the result has always been that in the end the subject has become clearer to the student and, as I have been assured, even more interesting.

K. E. GUTHE

THE EVOLUTION OF INTELLIGENCE AND ITS ORGANS[1]

WE recognize two very distinct types of physiological functions: (1) activities concerned with the inner working of the bodily mechanism—nutrition, internal regulation, etc.—and called vegetative or visceral functions; (2) activities concerned with the adjustments of the body to outside, or environmental influences. These we call somatic functions.

These reaction types are, of course, always intimately related and interdependent; nevertheless, as we ascend the scale of animal life the history of the evolution of both structure and function shows a progressive elaboration of each of these

[1] Address of the vice-president and chairman of Section F—Zoology. American Association for the Advancement of Science, Boston, 1909.

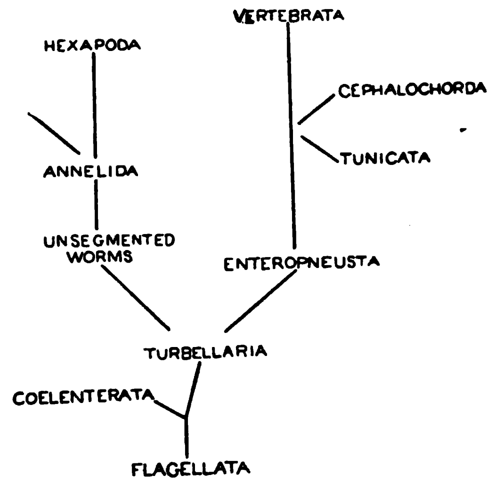
two functional systems and differentiation from the other, so that in higher vertebrates the distinction between them may be said to be fundamental both to anatomy and to physiology.

As children we probably considered the chief distinction between plants and animals to be the ability of the latter to move freely about; but one of the first lessons in our elementary biology was the correction of this notion by the study of sedentary animals and locomotor plants. Nevertheless, I fancy that in the broad view the childish idea has the root of the matter in it. The plants and sedentary animals may have their vegetative functions of internal adjustment never so highly specialized and yet remain relatively low in the biological scale because their relations with the environment are necessarily limited to the small circle within which they first take root, whereas the power of locomotion carries with it, at least potentially, the ability to choose between many more environmental factors. It is only the free-moving animals that have anything to gain by looking ahead in the world, and here only do we find well-developed distance receptors, *i. e.*, sense organs adapted to receive impressions from objects remote from contact with the body. And the distance receptors, as we shall see, have dominated and set the direction of the evolution of the nervous system in vertebrates.

Thus arose the animal head, with its three important functions of feeding, breathing and the recognition of mates and enemies. Parker has recently reviewed[2] in an illuminating way the earlier stages in the differentiation of the nervous system and I shall not attempt to go over this ground again, but will take a bilaterally symmetrical segmented animal with a differentiated head end as the point of departure in an examination of the phylogenetic history of behavior types.

[2] Parker, G. H., *Popular Science Monthly*, 1909.

On anatomical and zoological grounds zoologists are in the habit of subdividing the animal kingdom in the way roughly suggested by the accompanying scheme. Most of the important groups are naturally arranged in two great phyla which have apparently been quite distinct as far down as the flat worms. One of these, which we may call the articulate phylum, includes



the segmented worms, crustaceans, spiders and insects; the other phylum, after passing through a series of obscure invertebrate stages, largely at the present time extinct, culminates in the true vertebrates. It may be termed briefly the vertebrate phylum, and all of its members, from the lowest to the highest, are sharply distinguished from those of the articulate phylum by several characteristics, among which is the development of mesodermal gut pouches. All forms above the Enteropneusta have gill clefts, either embryonic or adult, which likewise develop as gut pouches and a dorsal tubular nervous system, which is derived from the mid-dorsal ectoderm and is separated from the gut by a supporting notochord. The articulates, on the other

hand, have a ladder-like nervous system ventrally of the gut and of totally different origin.

These are illustrations of the nature of the data on the basis of which zoologists are in quite general agreement in recognizing the wide divergence of these two great phyla of metazoa.

Now, students of animal behavior have recognized also two fundamental behavior types among the higher animals. This is clearly stated by Yerkes when he points out[3] that the animal kingdom presents divergent lines in the development of action types.

> Certain animals are markedly plastic or voluntary in their behavior, others are as markedly fixed or instinctive. In the primates plasticity has reached its highest known stage of development; in the insects fixity has triumphed, instinctive action is predominant. The ant has apparently sacrificed adaptability to the development of ability to react quickly, accurately and uniformly in a certain way. Roughly, animals might be separated into two classes: those which are in high degree capable of immediate adaptation to their conditions, and those which are apparently automatic since they depend upon instinctive tendencies to action instead of upon rapid adaptation.

If time permitted us to develop this conception, many striking illustrations might be cited of the predominance of now one, now the other, of these action types in different animals. The most striking feature of such an examination is the discovery that, while the generalized members of both of the zoologists' phyla exhibit an extreme development of neither action type, those forms which are structurally highly specialized generally have one or the other action type also highly developed; and in these cases an arrangement of animals according to their type of behavior follows closely the diphyletic arrangement previously elaborated on purely structural grounds. The anatomical basis of this harmony is readily apparent when the nervous systems of the two phyla are compared.

[3] *Journal of Comparative Neurology and Psychology*, Vol. 15, 1905, p. 137.

The central nervous system of the articulates is fundamentally a segmented ladder-like chain of nerve tissue with special ganglionic enlargements in the head related to the leading sense organs. It is dominated by the general body metamerism and the segmental reflex arcs are kept relatively distinct by the anatomical configuration. Some of the compound and chain reflexes are very complex; yet they tend to follow the appropriate stimuli with a mechanical precision which is simply an expression of the accurate working of a pre-formed mechanism. Since this is an inherited mechanism, all members of the species exhibit similar reactions and these do not require experience for their performance. This is instinct.

On the other hand, the vertebrate nervous system is fundamentally an epithelial tube, only imperfectly segmented, which contains not only direct reflex mechanisms of the articulate type, but also a massive continuous column of nerve cells and connecting fibers, the reticular formation, which is a diffuse correlation center related to all of the reflex arcs. In the head there are special enlargements derived from this (incompletely) segmented reticular formation, which make up the greater part of the brain in a higher vertebrate. These are the special correlation centers or the suprasegmental apparatuses of Adolf Meyer's terminology.

The entire vertebrate plan of nervous system is totally different from that of any member of the articulate series and, while adapted to perform stereotyped reflexes and instinctive modes of behavior, is also capable of wholly different types of reac-

tion based on the functional plasticity of the reticular formation and its derivatives. There is, of course, some measure of plasticity in the behavior of arthropods, *e. g.*, some ability to learn by experience, and they possess some tissue corresponding to the reticular formation; but in the broad view the distinctions just drawn are characteristic of the two phyla.

Without going into further detail, we may, then, generalize that the higher insects mark the culmination of the stereotyped or instinctive type of behavior, while the primates represent the culmination of the plastic, docile or rational type, and that the structural basis of this plasticity of the vertebrates is found in the relation of the reticular formation of their nervous systems to the other elements of the neural tube and especially in the suprasegmental correlation centers derived therefrom. The lower vertebrates are far inferior to the higher insects in many respects—often perhaps in the very ability to profit by experience of which we have been speaking; but their physical organization is such as to favor future differentiation in this direction, while that of the insects is such as to forbid it. Thus it appears probable that the dominance of the vertebrate type was foreshadowed far back among the ancestral crawling things in which no truly vertebrate character was manifest, foreshadowed merely by a structural type with different latent potencies.

The arthropod type of organization and action system is rigidly stereotyped in the race as well as in the individual; *i. e.*, it tends to be transmitted without modification from generation to generation. Its pattern can be changed only by natural selection or some other agency which can act through heredity. The more plastic vertebrate type is not fixed completely at birth by heredity, but its precise form is more largely acquired as individual experience advances. As intelligence plays a progressively greater part in the behavior, infancy will be prolonged to afford the necessary opportunity for the plastic nervous system to be shaped in adaptation to the individual needs of the animal. The instruments of racial progress here are not merely natural selection acting through heredity, but also docility, social heredity and organic selection, acting largely through intelligent adaptation.

In the vertebrates the amount of preformed or inborn organization, both of structure and of function, is in general greater than in arthropods; but there is superposed upon this rigidly predetermined tissue in higher vertebrates the unspecialized embryonic correlation tissue, the details of whose organization are not laid down in the hereditary pattern, but are individually acquired during development. The ultimate pattern which will be assumed by this plastic tissue is largely shaped by the exigencies of function during the period of its immaturity and this in turn rests upon the nature of the environmental factors. In short, the educational period is limited to the age during which the epigenetic tissue, *i. e.*, the correlation centers whose form is not predetermined in heredity, retains its plasticity under environmental influence.

Ultimately even the cerebral cortex matures and loses its power of reacting except in fixed modes. Its unspecialized tissue —originally a diffuse and equipotential nervous meshwork—becomes differentiated along definite lines and the fundamental pattern becomes more or less rigid. The docile period is past and, though the man may continue to improve in the technique of his performance, he can no longer do creative work. He is apt to say, "The dog is too old to learn new tricks." Whether

this process occurs at the age of twenty or eighty years, it is the beginning of senility. And, alas, that this coagulation of the mental powers often takes place so early! Many a boy's brains are curdled and squeezed into traditional artificial molds before he leaves the grades at school. His education is complete and senile sclerosis of the mind has begun by the time he has learned his trade. For how many such disasters our brick-yard methods in the public schools are responsible is a question of lively interest.

We who seek to enter into the kingdom of knowledge and to continue to advance therein must not only become as little children, but we must learn to *continue so.* The problem of scientific pedagogy, then, is essentially this: to prolong the plasticity of childhood, or otherwise expressed, to reduce the interval between the first childhood and the second childhood to as small dimensions as possible.

The docile or educational period of a mammal is largely devoted to the progressive mechanization of the in-born plastic tissue of the higher correlation centers, *i. e.*, to habit formation, or otherwise expressed to the elaboration of acquired automatisms and reflexes of the type commonly referred to as lapsed intelligence. Much confusion has arisen from the failure to distinguish these individually acquired automatisms from those performed in the hereditary pattern, *i. e.*, lapsed intelligence from true instinct.

Now to return from this digression, let us consider some data bearing on the phylogeny of the nervous functions in vertebrates. We have commented upon the fact that the tubular form of the vertebrate nervous system presents mechanical advantages over the ladder-like form of the articulates for the development of correlation tissue and that the parent type of this tissue is found in the central gray and reticular formation which borders the gray matter in the spinal cord.

The nervous mechanism of the remarkable adaptiveness, the apparent purposefulness, of the spinal cord reflexes has been lucidly explained by Sherrington in his Silliman lectures, where he shows that one of the chief functions of the correlation cells of the gray matter (cells of the reticular formation type) is the elaboration of a single final common path adapted to serve, as occasion may require, a large and variable number of receptors and afferent paths. Although this apparatus reacts largely in a fixed and invariable mode depending on the internal connections of the neurones of which it is composed, nevertheless it possesses a certain amount of flexibility growing out of a variable internal resistance at the synapses, or points of physiological union of one nerve cell with another, and particularly the modification of this resistance by practise or habit. This modifiability is not *per se* evidence of anything psychic; for we find it in unicellular animals and plants with no nervous system and even in many dead mechanisms; yet this feature is the point of departure for those higher types of correlation centers which serve as the organs of mind *par excellence.*

In the head end of the neural tube there is an obvious tendency for the peripheral nerves serving a single function to converge just before or just after they enter the brain so as to reach a single primary center. This concentration of functional systems is obviously advantageous in facilitating the distribution of afferent impulses to their proper motor organs, especially the total reactions so characteristic of vertebrate life as distinguished from the segmental reflexes characteristic of worms and insects. The enlargement of these primary

sensory centers, which sometimes attain to enormous size, does not imply any more highly developed psychic powers than those of allied species with smaller brains; but rather a higher elaboration of certain reflex activities only.

The same is in large measure true of certain suprasegmental or secondary correlation centers. Thus, each one of the organs of higher sense discharges its afferent impulses into a massive primary receptive center and this in turn transmits it to correlation centers of the second, third and higher orders, where these nerve impulses are brought into relation with those from other sense organs and with the appropriate efferent pathways to the muscles or other organs of response. The correlation centers of this sort, which make up a large part of the thalamus and midbrain, are derivatives of the formatio reticularis tissue and are functionally of the same type. They permit of wonderfully complex discriminative reactions and are more readily modifiable by experience than are those of the spinal cord and medulla oblongata.

There is another type of highly developed correlation center whose psychic value is still less than the sensori-motor stations of which we have just been speaking. I refer to the central mechanism of what Sherrington calls the proprioceptive system.[4] Of this the cerebellum is the most important example. The chief function of this system being the coordination and regulation of the skeletal musculature and other organs of somatic response (as distinguished from the interoceptive or visceral effectors), it is naturally purely reflex and its function is disturbed rather than facilitated by voluntary interference.

The correlation centers of the cerebral hemispheres occupy a unique position. Their interpretation is possible only in the light of their origin in the lower groups of vertebrates. Numberless researches by our most able anatomists and physiologists have accumulated a vast wealth of data on this subject, which have, however, stubbornly resisted correlation and interpretation. Our debt to the generalizations and luminous terminology of Sherrington appears on almost every page of this address. Let us begin our inquiry into the origin of cortical function with an examination of a typical feeding reaction.

The primitive feeding reactions are very simple reflexes, but even in the lowest animals they are easily modifiable, as Jennings has shown for protozoa and Parker for sea anemones. Predaceous species among the lowly vertebrates commonly hesitate long before they strike, but once the action is initiated it follows to completion in a very precise and invariable fashion. The pike or the frog will watch the moving prey long before the forward leap is made to seize it; but when once taken it will generally be swallowed at once whether it be a living fly or an artificial one.

Sherrington in discussing this reaction divides it into an anticipatory phase—fixation, coordination of somatic movement for the leap and seizure—and a consummatory reaction of mastication, swallowing, etc. It is the latter alone which gives satisfaction and in the interval which elapses between the beginning of the anticipatory reaction and the consummatory reaction we shall find the key to the problem of cortical function.

The whole feeding reaction in the lowest animals is so far as we can judge a blind reflex; the consummatory phase is largely so even in the highest animals, for once a morsel is in the mouth the processes of mastication and deglutition go on quite automatically.

[4] On the relation of this system to the exteroceptive, see my article on the "Morphological Subdivision of the Brain," *Journal of Comparative Neurology and Psychology*, Vol. 18, 1908, p. 395.

With the anticipatory phase, however, the case is quite different. The more complex the feeding act becomes, the more prolonged and difficult is this phase of the process. In the case of carnivorous vertebrates the prey must be recognized at a distance and carefully stalked and attacked from the most advantageous side, and all of these details will vary with each trial. No combination of simple reflex arcs can be laid down in advance within the nervous system which will be adequate to meet the infinite variations of these problems.

We may hypothecate the course of the evolution of this reaction as follows: In the lower animals, as in the spinal cords of the higher ones, the whole formatio reticularis, or correlation tissue, is relatively unspecialized and receives all kinds of afferent impulses from the primary sensory centers; these in turn it delivers over to the final common efferent pathways. There is thus a constant collateral avenue of nervous discharge through the reticular formation parallel with that in the primary reflex arcs and reinforcing, inhibiting or otherwise modifying these primary simple reflexes.

The character of the efferent discharge from this reticular formation will depend upon the sources and strength of the afferent impulses, the fluctuating internal resistance of the chains of neurones of which it is composed and other variable factors, some of which, like the resistance at the neurone thresholds, may be modified, as already pointed out, by repetition of function (habit formation).

The suprasegmental correlation centers present essentially the same dynamic aspect, but with the afferent pathways more sharply defined and limited and the whole more perfectly adapted to effect definite types of more complex correlation. Thus, the thalamus becomes a great center for the correlation of somatic reflexes and the hypothalamus for visceral and olfactory reflexes. Accordingly, all of the lower primary correlation centers send strong secondary tracts upward into the diencephalon.

Now to return to the feeding activities, so far as these are contact reactions, such as nosing about in the mud for food, the interval between the anticipatory and consummatory phases is not necessarily long and a very simple reflex mechanism is adequate to distinguish between food and other objects.

But in the more complex cases the interval between the anticipatory and consummatory phases is occupied by the discharge into the higher correlation centers of a series of momentarily changing stimuli from the distance receptors, and the later acts of this phase will be the resultants of all of these influences plus the effects in the centers themselves of vestiges of similar reactions in the past. The whole system is in a state of neural tension which varies constantly as new impulses from the periphery reverberate through its substance. The high neural resistance of this complex tissue raises the threshold of discharge from it so that a certain summation of stimuli takes place before the tension is relieved by a discharge of the neural energy into the lower mechanism of the consummatory reaction, which is already so adjusted as to perform its functions when once actuated more or less mechanically and therefore without the development of such internal resistance as characterizes the anticipatory mechanism.

In the storm and stress of this interval just preceding the consummatory reaction the higher mental faculties are born.

The stream of nervous influences pouring into the higher correlation centers from

the peripheral sense organs contains many elements of no significance to the immediate capture of the quarry. These stimuli the animal learns to ignore, perhaps in the first instance unconsciously, by an application of the biological law of habit; for those reflex arcs which have adaptive value in this particular situation will lead at once to the desired consummatory reaction, leave their permanent vestiges in the nervous system and so be more easily repeated, while the irrelevant stimuli do not lead to a relief of the tension, come to nothing and leave no such vestiges. Upon later repetition of the series, the adaptive stimuli find a more open path through the nervous system than the non-adaptive, and accordingly they from the start tend to set the direction of the nervous discharge through the correlation centers, and during this process the sense organs are reflexly adjusted to the sources of these relevant stimuli to the exclusion of the irrelevant. This is the origin of attention.

The analysis of other types of distance reactions, such as avoidance of enemies, search for mates, etc., would show for them a similar significance for psychogenesis. The important point is that these complex forms of distance reaction demand for their highest efficiency greater flexibility and modifiability of response than do the visceral and contact reactions. Here only is a high degree of intelligence necessary. The cortex cerebri dominates cerebral architecture only in mammals where complex anticipatory reactions dominate the behavior, and foresight, literal and figurative, plays the leading rôle.

The cerebral cortex is a correlation center of a higher order, *i. e.*, farther removed from the primary sensori-motor reflex arcs, than those of the brain stem. It is not different in kind from those centers, but only in the extent of its removal physiologically from the primary centers and the nature and complexity of the associational connections within it. In the lower vertebrates the steps by which it has been gradually lifted above the lower correlation centers can now be traced with a considerable degree of precision. Some of this evidence will be reviewed in the symposium on comparative neurology to be held to-morrow in the meeting of the Association of Anatomists. We have time here merely to state in brief summary a few salient features.

We owe to the genius of Edinger the suggestion that the earliest stages in the origin of the peculiarities of the cerebral hemispheres must be sought in a study of the character of the reflexes connected with the nose and lips, particularly the feeding reactions. These have been termed collectively the "oral sense" (Edinger) or "*Schnüffelsinn*" (Kappers) and may perhaps best be called the muzzle reflexes.

In lower vertebrates the sense organs of the nose are probably the most important receptors in the muzzle reflex complex, and these are distance receptors and not contact receptors. Accordingly, the cerebral hemispheres were built up on the basis of the olfactory correlation centers, or rhinencephalon. In fishes, long before we find a true cerebral cortex, ascending tracts pass from the visceral sensory centers of the hypothalamus (probably mainly gustatory in function) and from the somatic centers of the thalamus and midbrain (mainly tactile in function) to enter the large forebrain correlation centers related to the olfactory apparatus. The association of these sensory elements and their return motor tracts produces the so-called corpus striatum of fishes, an apparatus which is probably largely concerned with reflexes of the nose, lips and mouth.

In Amphibia important optic projection

fibers are added, passing from the external geniculate body of the thalamus to the hemispheres, and also acoustic fibers from the inferior colliculus of the midbrain. Though there is no true cerebral cortex here, the tissue from which it is to arise in reptiles can be definitely identified and this tissue is in the frog clearly divided into a medial part, serving primarily the correlation of olfactory and visceral reflexes, and a lateral part, serving primarily the correlation of olfactory and somatic reflexes. The former gives rise in higher animals to the hippocampus, the latter to the pyriform lobe (uncus), while the rest of the cortex, or neopallium, is in these animals differentiated dorsally between these two masses and serves chiefly for the correlation of non-olfactory reactions.

The two parts of the pallium which we call archipallium and neopallium (*i. e.*, olfactory and non-olfactory cortex) are not of different age, as the names imply. They probably both arose at the same time to serve the delicate discriminative reactions of the muzzle reflexes. Their precursors are found in fishes and amphibians, where their cells are mingled in an undifferentiated tissue which has been called by some authors the epistriatum. They finally (in reptiles) become separated and within each division in mammals subordinate "areas" with more or less characteristic connections are differentiated. The incompleteness of this differentiation is responsible for much of the controversy which has waged regarding the presence and significance of localizable cortical areas.

No cortical area can properly be described as the exclusive center of a particular function. In higher mammals it is true that the several final common paths for particular effectors leave more or less clearly defined areas of cortex and that the several kinds of sensory projection fibers terminate in other more or less definite areas. But these so-called sensory and motor areas are in no proper sense centers for the performance of definite functions. Such a "center" is merely a nodal point in an exceedingly complex system of cells and fibers which must act as a whole in order to perform any function whatsoever. Their relation to cerebral functions is analogous to that of the railway stations of a big city to traffic, each drawing from the whole city its appropriate share of passengers and freight, and their great clinical value grows out of just this segregation of fibers of like functional systems in a narrow space, and not to any mysterious power of generating psychic or any other special forces of their own.

The essence of cortical function is correlation and a cortical center for the performance of a particular function is a physiological absurdity, save in the restricted sense described above, as a nodal point in a very complex system of associated conducting paths. Those reflexes whose simple functions can be localized in a single center have their mechanism abundantly provided for in the brain stem.

In the broad view we may say that intelligence is a function of the cerebral cortex, but only in the sense that here are found the most complex correlations in the chain of vital response whose initial phase is to be sought in the environment which supplies the stimulus and whose final phase is also found in the changes wrought in the environment by the bodily reaction. A similar function is performed in a less perfect way in lower animals which lack the cerebral cortex, and doubtless even in man the subcortical nervous apparatus still plays an important part in all conscious processes.

The resting brain is probably normally during life in a state of neural tension in more or less stable equilibrium. An effective stimulus disturbs this equilibrium and the precise effect will depend upon variable synaptic resistance or neurone thresholds which change with different functional states of the organism as a whole and of the brain in particular. If this activity involves the cerebral cortex of a human brain, it may be a conscious activity, the kind of consciousness depending on the kind of discharge. But the consciousness must not be thought of as localized in any cortical area.

The discharge in question may reverberate to the extreme limits of the nervous system and the peripheral activities may be as essential in determining the conscious content as the cortical. Indeed, we have considerable evidence that many of our conscious acts take their most distinctive psychic qualities from the "back stroke," or reverberation of a neural discharge from the periphery back to the cortex.

Thus far we have tacitly assumed that consciousness is an integral part of the complex of bodily functions. This assumption lies at the basis of most modern work in the field of comparative psychology and rests on the thoroughly scientific basis of a large body of observation and inference. In the nature of the case demonstrative proof is impossible, for consciousness as I know it is a purely individual experience; but without the assumption that like behavior in other men implies experience like my own in similar circumstances the science of psychology can not go on, and without the further assumption that other animals have like experience in proportion as their behavior is like my own comparative psychology is an impossible science.

Now keeping in mind the dynamic conception of the workings of the nervous mechanism developed above, let us see whether the introspective examination of some very simple conscious reaction can be put into scientific relation with other biological processes, or whether it must be left out of our science in the cold isolation of mere epiphenomena and similar metaphysical abstractions.

An unfamiliar or unexpected sensation is experienced; let us say a noise. There is a moment of hesitancy while the sensory stimuli, numerous awakened memory vestiges, each perhaps with its own emotional coloring, and many half-formed impulses, surge in consciousness. When the problem presented by the new situation is solved, the mental tension is relieved and the intellectual process crystallizes at once into action. I *am thinking* about it no longer: I *have got* an idea; and the appropriate act follows immediately and automatically unless inhibited by some extraneous influence. Here we have an active and complex interplay of conscious elements corresponding to what in the objective manifestation we called the anticipatory phase of the reaction, and the conscious process comes to an abrupt end as soon as it passes over into the already stereotyped form of reaction. That is, *this* conscious process ends, though of course it may be followed at once by another similar chain of events.

Here we see how intelligence and feeling are developed as the servants of action. They do not appear so long as the action can be effected without them and they vanish as soon as the reflex machinery of an adaptive action is set in motion. *Consciousness is a functional phase of the more complex mechanism of those higher non-stereotyped actions for which the reflex machinery is inadequate, in much the same way that the tropisms of Paramecium and the sucking reflex of an in-*

fant are functional phases of the simple inborn neuro-muscular mechanisms of these organisms.

We do not know whether any glimmer of consciousness is involved in these simple processes; but if we study the behavior of the whole series of animals from *Amœba* to man *objectively,* we can find no point where to an outside observer the behavior which we called discriminative reaction in a protozoan passes over into conscious choice as we see it in our fellow men. The series of stages is complete and unbroken until I begin to study *my own* choices, when I find by introspection that the whole mental fabric is involved—ratiocination, swayed perhaps now this way, now that, by waves of feeling, and finally will. Out of the psychic chaos of hesitation and doubt I say, and I say truly, "I have made up my mind," and action results.

Now this seems to me a very different thing from the discriminative reaction of an amœba, or even the deliberately judicious act of a fellow man. Both of the latter are alike in that *I* do not directly experience feeling, will, etc., in connection with them. Possibly if I could be successively for a time an amœba, a sea anemone, a frog, a man and all the types of animals between by the act of some benevolent Buddha, and if I could carry my memory of each stage through all of the others, then perhaps the psychic series would appear at the end a simple and unbroken graded series, as the objective physiological series does to me now.

Meanwhile, without intending at this time to penetrate far into a field of philosophical speculation which clearly lies beyond the present limits of biological science, I wish to make one further observation on the great problem of the relation of mind and body. We have seen that animal bodies can be arranged in a graded series (not a simple *linear* series, to be sure, but a true series, nevertheless) of genetically related forms; that animal activities can be arranged in a similar graded series of functions; and that these two series are closely related. In fact, they are absolutely inseparable except by logical abstraction or some artificial scientific procedure, for their respective members are related to each other as structure and function, as objects and their properties, and neither can exist apart from the other.

There is, however, a third series, the psychic series, of which I know *directly* only one member—my own experience. But I have satisfactory indirect evidence that the psychic series also extends for at least a part of the distance parallel with the other two. And wherever I can analyze this evidence it teaches that psychic processes, like physiological processes, are related to living bodies as functions of their structures. If it be permissible to generalize from these facts, and say that both physiological and psychological processes may be included in the one category of function, we may conclude that we have not to reckon in science with three independent genetic series, anatomical, physiological and psychological, but with one—a single series of functioning structures, whose genetic continuity is unbroken from its simplest to its most complex members and which can be dissociated, as is commonly done, only by doing violence to truth.

The present isolated position of the three disciplines of anatomy, physiology and psychology is due partly to the exigencies of practical pedagogical and methodological convenience and partly to our incomplete knowledge of the facts.

It is perhaps well to add that the position here defined is as far removed as

possible from that naïve materialism which would postulate a single series of objects as the ultimate realities with more or less adventitious functions pertaining to them as epiphenomena. The analysis here attempted is merely pragmatic and proximate, not ultimate, and it leaves quite to one side and untouched the metaphysical problem of the ultimate nature of the phenomenal series, whether it is materialistic or idealistic or both or neither.

Looking back now over the field which we have traversed, in our analysis of the behavior of animals and its mechanisms we start with the tropism and the reflex. This type of response is in some of its simpler phases indistinguishable from the reactions of dead machines to the forces which actuate them. But the more complex reflexes, on the other hand, grade over into those behavior types which we call intelligent. No one has yet succeeded in formulating a clear-cut definition of the limits of the reflex at either its lower or its higher extreme, and perhaps no one ever will; for the whole list of behavior types from machines to men probably forms a closely graded series.

Even the simpler reflexes exhibit a measurable refractory phase, or pause, in the center where the afferent impulse is made over into the efferent. When reflexes are compounded, there is another factor which may tend to modify or delay the response. This is the dilemma which arises when two or more reflex centers are so related that a given afferent impulse coming to one of them may take any one of several final common paths to the organs of response. The reflex response which actually emerges in such a case will generally be the adaptive one, *i. e.*, the one which is best for the organism. The selection of the adaptive response in such a case may be termed *physiological choice,* and it always involves a lengthening of the refractory phase.[5] In the neural tensions of the refractory phase of physiological choice we find the germs of the complex anticipatory reactions which in turn have nurtured the awakening intelligence.

I have atempted to illustrate the thesis that the comparative study of animal behavior in the broadest sense of the term is as essential as other branches of physiology to the comprehension of animal structures and that the enlargement of our knowledge of scientific fact in this field will contribute greatly to the more perfect integration of the three great branches of biology—anatomy, physiology and psychology—and the correlation of the whole with other departments of knowledge. Our philosophy of nature is sound just in proportion as we succeed in effecting these correlations of experience.

C. JUDSON HERRICK

THE ALASKAN FUR-SEALS[1]

WHEN, on January 1, 1909, the management of the Alaskan fur-seal fisheries was transferred to the United States Bureau of Fisheries, the Secretary of Commerce and Labor designated Dr. David Starr Jordan, Dr. Leonhard Stejneger, Dr. C. Hart Merriam, Dr. Frederic A. Lucas, Dr. Chas. H. Townsend, Hon. Frank H. Hitchcock and Hon. Edwin W. Sims, to act as an advisory board to recommend measures designated to conserve this valuable animal life now being exterminated through sea-killing of breeders. On November 23, last, this board met at the Bureau of Fisheries in Washington and adopted the following recommendations, which

[5] Physiological choice, in fact, is not dependent upon a nervous system at all, but has been demonstrated in rudimentary form even among Protozoa, though it remains on a very low plane in these organisms.

[1] Published by permission of Hon. Geo. M. Bowers, U. S. Commissioner of Fisheries.

were placed in the hands of the Secretary of Commerce and Labor:

Recommendations.—Agreed on by the Advisory Board Fur-Seal Service (Dr. David Starr Jordan, chairman; Dr. Leonhard Stejneger, Dr. Frederic A. Lucas, Mr. Edwin A. Sims and Dr. Charles H. Townsend), in conference with the Fur-Seal Board (Dr. Barton Warren Evermann, chairman; Mr. Walter I. Lembkey and Mr. Millard C. Marsh), the Commissioner of Fisheries (Hon. Geo. M. Bowers), the Deputy Commissioner of Fisheries (Dr. Hugh M. Smith), Assistant Fur-Seal Agent, H. D. Chichester, and Special Scientific Expert, Mr. Geo. A. Clark, at a meeting held at the Bureau of Fisheries, November 23, 1909, all the above-mentioned persons being present, and the action on each recommendation being unanimous.

1. It is recommended that the agent in charge, fur-seal service, shall, under the direction of the Secretary of Commerce and Labor, have full power to limit or restrict the killing of fur-seals and blue foxes on the Pribilof Islands to any extent necessary and that no specified quota be indicated in the lease.

2. It is recommended that, for the present, no fur-seal skin weighing more than 8½ pounds or less than 5 pounds shall be taken, and that not more than 95 per cent. of the three-year-old male seals be killed in any one year.

3. It is recommended that there be adopted a system of regulations similar to those in force on the Commander Islands, the government to assume entire control in all essential matters pertaining to the fur-seals, blue foxes, natives and the islands in general, and the lessee to be restricted to the receiving, curing and shipping of the skins taken.

4. It is recommended that there shall be added to the personnel of the fur-seal service a chief naturalist who shall have charge of all matters pertaining to the investigation, study and management of the fur-seal herd, the blue foxes, and all other life on the islands, and who shall give advice to the agent in charge regarding the number of seals and foxes to be killed each season. The chief naturalist should be a man of recognized standing and experience, and his salary should be not less than $3,000.

It is also recommended that there be at least one assistant naturalist whose salary should not be less than $1,800.

5. It is recommended that the agent in charge shall have control of all administrative matters, and in case of a difference of opinion between the chief naturalist and the agent in charge, the decision of the latter shall govern, pending an appeal to the Secretary of Commerce and Labor.

6. It is recommended that there be arranged a conference of scientific men and diplomats of Great Britain, Canada, Japan, Russia and the United States, for consideration of the question of pelagic sealing as well as of an international game law to protect whales, walrus, sea-otter and other mammals of the sea, the agreement reached by these nations to be submitted to the other maritime nations for their concurrence.

In addition to the above, the conference unanimously adopted the following resolution:

Resolved, That we thoroughly approve of the sentiments set forth in the letter of the Commissioner of Fisheries, dated November 17, 1909, addressed to the honorable, The Secretary of Commerce and Labor, in which was urged the necessity of early action which will result in the stopping of pelagic sealing.

THE KUSER ASIATIC EXPEDITION

On December 29 Mr. C. William Beebe, Curator of Birds in the New York Zoological Park, sailed on the *Lusitania* for London, accompanied by Mrs. Beebe. Mr. Bruce Horsfall, artist, will follow on a later steamer. After several weeks' study of the pheasants in the British Museum, Mr. Beebe will proceed direct to Ceylon and India, where field studies will be made of the wild pheasants and jungle fowl. The object of the expedition is to obtain data, both written, photographed and painted, concerning the ecology of the Phasianidæ. The tentative itinerary includes the Himalayas, Burma, Sumatra, Java, Borneo, Cochin China, Palawan, Formosa, eastern China and

Japan, the party returning by way of Honolulu and San Francisco.

Mr. Beebe has been granted a twelve months' leave of absence without pay, and in his absence his correspondence and the continuing of his experimental work at the Zoological Park will be carried on by Mr. Lee S. Crandall.

The results of the expedition will be published in monographic form, illustrated with colored plates of all the more important species of pheasants, by Charles R. Knight, Louis Agassiz Fuertes and Bruce Horsfall. The treatment will be rather from the point of view of the ecology of the living birds and their care in captivity, than systematic and anatomical.

Living specimens of Argus and other rare forms will be brought back together with as complete a collection of skins, and studies for backgrounds. The wide-spread interest in pheasants in this country and the lack of knowledge of their habits in a wild state seem to indicate a field for such a work.

The expedition will be made, and the monograph published under the auspices of the New York Zoological Society. Credit for the inception and the entire financing of the expedition and monograph, is due to Colonel Anthony R. Kuser, of Bernardsville, New Jersey. The success of the undertaking will be altogether due to that gentleman's enthusiastic love of birds and disinterested generosity.

Mr. Beebe is in charge of the bird collection and the experimental station at Faircourt Aviaries on Colonel Kuser's estate, and the painting and all other monographic work will be carried on at that place.

MUNICIPAL CHEMISTRY

THE department of chemistry of the College of the City of New York offers during the spring semester a course of thirty lectures on the chemistry of daily life. These lectures will be open to three classes of hearers: (1) Senior students of the college who have complied with the requirements of the department. (2) Employees of the city who have studied sufficient chemistry to pursue the laboratory work. (3) A limited number of auditors composed of citizens of the city will be admitted on applying for a seating to the director of the department. The lectures will be given at 4 P.M., in the Doremus Lecture Theater, Chemistry Building, 140th Street and Convent Avenue, Plaza Entrance.

The program is as follows:

February 4—"Sanitation" (introductory lecture), by Professor Charles Baskerville, director of the department of chemistry, College of the City of New York.

February 9—"Drinking Water and Disease," by Dr. William P. Mason, professor of chemistry, Rensselaer Polytechnic Institute, Troy, N. Y.

February 10—"Sources of Municipal Water Supply," by Dr. William P. Mason.

February 11—"The Purification of Polluted Water," by Dr. William P. Mason.

February 15—"Milk," by Dr. Thomas C. Darlington, commissioner of health, New York City.

February 18—"The Purpose, Method and Extent of Food Adulteration," by Dr. Harvey W. Wiley, chief, Bureau of Chemistry, U. S. Government, Washington, D. C.

February 19—"The Remedy of Food Adulteration and Relation of Chemistry thereto," by Dr. Harvey W. Wiley.

February 25—"Food Inspection," by Mr. Bayard C. Fuller, chief food inspector, New York City.

March 1—"Spoiled Foods," by Mr. Bayard C. Fuller.

March 4—"Drugs and their Adulteration," by Dr. Virgil Coblentz, professor of chemistry, College of Pharmacy, Columbia University.

March 8—"Methods for Detecting Adulteration," by Dr. Virgil Coblentz.

March 11—"Habit Inducing Drugs," by Dr. Virgil Coblentz.

April 1—"Automobile Traffic and the Road Problem," by Dr. Allerton S. Cushman, acting director, Bureau of Roads, U. S. Department of Agriculture, Washington, D. C.

April 2—"Modern Road Construction," by Dr. Allerton S. Cushman.

April 5—"Street Sanitation," by Hon. William H. Edwards, commissioner of street cleaning, New York City.

April 8—"Disposal of Ashes and Light Rubbish," by Mr. Edward D. Very, sanitary engineer, department of street cleaning, and representative of the New York Sanitary Utilization Company.

April 12—"Disposal of Garbage," by Mr. Edward D. Very.

April 15—"Disposal of Putrescible Materials," by Mr. Edward D. Very.

April 19—"Manufacture of Gas," by Dr. Arthur H. Elliott, chemist to the Consolidated Gas Company, New York City.

April 22—"Means of Testing the Properties and Quality of Gas," by Dr. Arthur H. Elliott.

April 26—"The Smoke Problem," by Dr. Arthur H. Elliott.

April 29—"Ventilation," by Dr. Herbert R. Moody, associate professor of chemistry, College of the City of New York.

May 3—"The Chemistry of Personal Hygiene," by Dr. Thomas A. Storey, director of the department of physical education, College of the City of New York.

May 6—Dr. Charles Edward A. Winslow, biologist in charge Sanitary Research Laboratory, Boston, associate professor-elect of biology, College of the City of New York.

May 10—"Paint and Painting," by Mr. Maximilian Toch, chairman New York Section, Society of Chemical Industry, and paint expert.

May 13—"Corrosion of Metals and its Prevention," by Mr. Maximilian Toch.

May 17—"Cement and Concrete," by Mr. Maximilian Toch.

May 20—"Combustibles and the Causes of Fires," by Dr. A. A. Breneman, expert to the Municipal Explosives Commission, New York City.

May 24—"Methods of Extinguishing Fires," by Dr. A. A. Breneman.

May 27—"City Parks, Gardens and Playgrounds," by Dr. N. L. Britton, director of the Botanical Gardens, Bronx Park, New York City.

COMPULSORY CONCENTRATION AND DISTRIBUTION OF STUDIES IN HARVARD COLLEGE

In pursuance of the resolutions of the governing board of Harvard University, printed in Science for December 17, the Faculty of Arts and Sciences, at its meetings on December 14 and 21, adopted the following rules, which will go into effect with the class entering in 1910:

I. Every student shall take at least six of his courses in some one department, or in one of the recognized fields for distinction. In the latter case four must be in one department. Only two of the six may be courses open to freshmen or distinctly elementary in character.

II. For purposes of distribution all the courses open to undergraduates shall be divided among the following four general groups. Every student shall distribute at least six of his courses among the three general groups in which his chief work does not lie, and he shall take in each group not less than one course, and not less than three in any two groups. He shall not count for purposes of distribution more than two courses which are also listed in the group in which his main work lies. The groups and branches are:

1. Language, Literature, Fine Arts, Music.
   - (a) Ancient Languages and Literatures.
   - (b) Modern Languages and Literatures.
   - (c) Fine Arts, Music.
2. Natural Sciences.
   - (a) Physics, Chemistry, Astronomy, Engineering.
   - (b) Biology, Physiology, Geology, Mining.
3. History, Political and Social Sciences.
   - (a) History.
   - (b) Politics, Economics, Sociology, Education, Anthropology.
4. Philosophy and Mathematics.
   - (a) Philosophy.
   - (b) Mathematics.

The committee was granted authority to arrange the various courses under the different groups and sub-groups by agreement with the departments in which the courses are given.

III. Prescribed work shall not count either for concentration or distribution.

The Committee on the Choice of Electives was instructed in administering these general rules for the choice of electives by candidates for a degree in Harvard College to make exceptions to the rules freely in the case of earnest men who desire to change at a later time the plans made in their freshman year, and to make liberal allowances for earnest students who show that their courses are well distributed, even though they may not conform exactly to the rules laid down for distribution. In making exceptions to the rules, a man's previous training and outside reading are to be taken into account.

SCIENTIFIC NOTES AND NEWS

DR. A. A. MICHELSON, professor of physics in the University of Chicago, has been elected president of the American Association for the Advancement of Science for the meeting to be held next year at Minneapolis. Vice-presidents of the sections have been elected as follows:

Section A—Mathematics and Astronomy—Professor E. H. Moore, University of Chicago.

Section B—Physics—Dr. E. B. Rosa, Bureau of Standards, Washington, D. C.

Section C—Chemistry—Professor G. B. Frankforter, University of Minnesota.

Section D—Mechanical Science and Engineering—Professor A. L. Rotch, Blue Hill Meteorological Observatory.

Section E—Geology and Geography—Dr. John M. Clarke, state geologist of New York, Albany, N. Y.

Section F—Zoology—Professor Jacob Reighard, University of Michigan.

Section G—Botany—Professor R. A. Harper, University of Wisconsin.

Section H—Anthropology and Psychology—Professor Roland B. Dixon, Harvard University.

Section I—Social and Economic Science—The Hon. T. E. Burton, Cleveland, Ohio.

Section K—Physiology and Experimental Medicine—Professor F. G. Novy, University of Michigan.

Section L—Education—President A. Ross Hill, University of Missouri.

Permanent Secretary—Dr. L. O. Howard, Washington, D. C.

General Secretary—Professor Frederic E. Clements, University of Minnesota.

Secretary of the Council—Professor John Zeleny, University of Minnesota.

Secretary of the Section of Social and Economic Science—Fred C. Croxton, Washington, D. C.

AT the recent Boston meeting of the American Society of Naturalists, Dr. D. T. MacDougal, director of the department of botanical research of the Carnegie Institution, was elected president and Dr. Charles R. Stockard, of the Cornell Medical School, secretary.

PROFESSOR W. D. BANCROFT, of Cornell University, has been elected president of the American Chemical Society. The councillors at large elected were: A. D. Little, of Boston; Dr. Leo H. Baekeland, of Yonkers, N. Y., and Professor W. L. Dudley, of Vanderbilt University.

PROFESSOR W. B. PILLSBURY, of the University of Michigan, has been elected president of the American Psychological Association.

AT the recent annual meeting of the New York Academy of Science, Professor James F. Kemp was elected president and Dr. Geo. F. Kunz, Dr. Chas. B. Davenport, Professor William Campbell, Dr. Maurice Fishberg, vice-presidents. Honorary members were elected as follows: Dr. F. K. Göbel, professor of botany in the University of Munich; Dr. Paul Groth, professor of mineralogy, University of Munich, Professor Alfred Lacroix, Musée d'Histoire Naturelle, Paris, Dr. August Weismann, professor of zoology, University of Freiburg.

AT the fifth annual meeting of the Southern Society for Philosophy and Psychology, held at Charlotte, N. C., on December 28, 1909, the following officers for the year 1910 were elected: *President,* Edward Franklin Buchner, Johns Hopkins University; *Vice-president,* Shepherd Ivory Franz, George Washington University; *Secretary-treasurer,* Robert Morris Ogden, University of Tennessee. A. Caswell Ellis, University of Texas, and David Spence Hill, Peabody College for Teachers, were elected members of the council to serve two years, and Bruce R. Payne, University of Virginia, and Haywood J. Pearce, Brenau College, to serve three years.

DR. EMIL FISCHER, professor of chemistry at Berlin, has been given an honorary doctorate in the natural sciences by the University of Brussels.

M. SIMON has been elected a corresponding member of the Paris Academy of Sciences, in the section for anatomy and zoology.

LIEUTENANT COLONEL D. PRAIN, director of the Kew Botanic Gardens, and Dr. F. O. Bower, professor of botany at Glasgow, have been elected corresponding members of the Munich Academy of Sciences.

AN oil painting by Mr. William Churchill of Professor William T. Sedgwick, head of

the department of biology of the Massachusetts Institute of Technology, has been presented to the institute by past students and associates. The portrait will be hung in the near future with appropriate ceremonies.

M. E. YSEAUX, professor of zoology and paleontology at Brussels, has retired from active service.

MR. HENRY B. HEDRICK, for many years assistant in the Nautical Almanac, U. S. Naval Observatory, has received an appointment in astronomy at Yale University, beginning January 1, 1910.

PROFESSOR WILLIAM MORRIS DAVIS gave a lecture before the geological department of Colgate University on the evening of December 20. His subject was, "The Italian Riviera Levante."

DR. J. C. BRANNER, professor of geology in Stanford University, will read a paper on "The Geology of the Black Diamond Regions of Bahia, Brazil" before the American Philosophical Society at the meeting on January 7.

A MONUMENT in memory of the eminent surgeon, Jules Péan, was unveiled before the hospital which he founded and which bears his name, on December 17. The address was made by M. Alfred Mézières, in the presence of the president of the republic and other distinguished guests.

SIR ALFRED JONES, who was largely responsible for the foundation and support of the Liverpool School of Tropical Medicine, has bequeathed the residue of his estate to public purposes to be selected by his executors, but with an indication favoring the School of Tropical Medicine. The estate is large, but the amount that will be available for public purposes is not known.

DR. P. FENNER, professor of geodesy in the Technical School at Darmstadt, has died at the age of fifty-six years.

THE fourth Congress for Experimental Psychology will meet at Innsbruck on April 19.

A FREE exhibition of 700 photographs illustrating the flora, fauna and scenery of central and western China was opened at Horticultural Hall, Boston, on December 27, to last two weeks. These photographs are the property of Arnold Arboretum, and were made by Mr. E. H. Wilson, the head of the Arboretum botanical exploration expedition, during the years 1907–8.

THE council of the New York Academy of Medicine announces that the income of the Edward N. Gibbs fund, amounting to five hundred dollars a year, will be granted for a period of years to a qualified worker to be selected by the council from those who may apply for its use in research in the clinical, pathological or chemical problems of diseases of the kidney.

THE Women's Medical Association of New York City offers the Mary Putnam Jacobi fellowship of $800 available for post-graduate study. It is open to any woman graduate in medicine. Applications should be forwarded to the chairman of the committee on award, Dr. Emily Lewi, 35 Mt. Morris Park, W., New York City.

THE following telegram, dated December 31, has been received at the Harvard College Observatory from Professor E. B. Frost, director of the Yerkes Observatory. "Prismatic camera shows light of Halley's comet to be now largely due to third cyanogen band."

DRS. JOHN F. ANDERSON and Joseph Goldberger, of the Hygienic Laboratory, U. S. Public Health and Marine-Hospital Service, who have been in Mexico City since November 1 studying typhus fever, have issued two notes on their work of much interest as to this disease. In the first paper they showed that Mexican typhus fever is not identical with Rocky Mountain spotted fever. In their second paper they report negative results in all their cultures. By the inoculation of blood from cases of typhus fever in two monkeys a course of fever resembling that in cases of human typhus was produced, ending in crisis in one case on the tenth day and the other on the thirteenth day. These papers were published in the Public Health Reports of December 10 and 24, 1909. Now that an animal susceptible to the disease has been found, it is hoped their

studies may result in determining the mode of transmission of this disease.

The course of lectures delivered by the Kaiser Wilhelm professor in Columbia University, Professor Carl Runge, of the University of Göttingen, is to be published in book form by Columbia University. The subject of the lectures is "Graphical Methods in Mathematics and Physics." The lectures treat of a subject which has not received sufficient attention either in this country or abroad. A considerable amount of the material contained in the lectures is original with Professor Runge. The methods studied have many important applications in astronomy, physics, engineering and various departments of technology.

The proper manipulation of the microscope requires an adequate knowledge of the optical and mechanical principles underlying its construction. As an adjunct to their treatise on the "Manipulation of the Microscope" by Edward Bausch, the Bausch & Lomb Optical Company has recently issued a chart of the microscope stand. Side by side are shown a perspective view and a vertical cross-section of the most modern type of instrument. The different parts and accessories are lettered and named and the path of the rays and the formation of the various images is shown. The chart, 3′ 6″ by 4′ 7″ in size, is executed in colors and mounted on cloth, with rollers at the top and bottom. It is a useful addition to the equipment of the laboratory and is now being distributed to the leading scientific institutions of the country.

Dr. Joseph E. Pogue, who is in charge of the Division of Mineralogy in the U. S. National Museum, has recently described in the Smithsonian "Miscellaneous Collections" a remarkable specimen of pyrite studded with crystals of gold and partly covered with plates of galena from the Snettisham District near Juneau, southeast Alaska. The pyrite is in the usual form of a cube, but what is very remarkable is that there are on it more than one hundred and thirty well-defined crystals of metallic gold. These are also in the cubical system and from one third to one half buried in the pyrite, never more, and seem to have no definite relation to the crystallization of the pyrite. Similarly crystals of galena and chalcopyrite are found on the pyrite. The structure and relation of the galena to the pyrite is of considerable scientific interest and is described in technical detail by the author.

UNIVERSITY AND EDUCATIONAL NEWS

An endowment fund of $500,000 for Trinity College has been raised.

Mr. N. T. Kidder has assumed the expense of the addition now being built for the Gray Herbarium, Harvard University, amounting to about $11,000. The corporation has voted to have this addition called the Kidder Wing.

Albert P. Sy, Ph.D., has been appointed professor of chemistry and director of chemical laboratories at the University of Buffalo, to succeed Dr. H. M. Hill, who resigned last summer.

Dr. E. C. Moore, superintendent of schools at Los Angeles, Cal., has been elected to the newly established professorship of education at Yale University and has accepted.

M. E. Balize, of Nancy, has been appointed professor of organic chemistry, at Paris, and is succeeded at Nancy by M. Grignard.

M. Lameere has been appointed professor of zoology and comparative anatomy at Brussels.

DISCUSSION AND CORRESPONDENCE

THE LUMINOSITY OF TERMITES

In Science of October 22, 1909, XXX., 574–575, Mr. Frederick Knab points out that the mounds made by certain Brazilian termites, or possibly the termites themselves, are luminous.

Although I have seen many thousands of the mounds made by termites in all parts of Brazil, I do not remember ever having observed this luminosity. A specimen of the nest materials was lately sent me by a Brazilian friend from the vicinity of Queluz, in

the state of Minas Geraes. This material shows no signs of luminosity at present, though it does not follow, of course, that it never was luminous.

The following note which I translate from "Viagem ao redor do Brazil," 1875–1878, pelo Dr. João Severiano da Fonseca, Rio de Janeiro, 1880, page 353, is much more to the point:

On the head waters of Rio Verde (state of Matto Grosso, Brazil) we saw one night a surprising sight. One of the white ants' nests seemed to be covered with little lights, and these tiny stars made it look like a miniature tower brilliantly illuminated. It was near the tent of Captain Craveiro, the commander of the troops, and that gentleman invited us to share his surprise and pleasure. When the nest was struck with a stick the miniature lights went out as if by enchantment, but only to reappear again little by little, beginning where the blows had been weakest.

I know but one other reference to this phenomenon in the works of Brazilian travelers, and that is the following brief note given in Castelnau's "Expédition dans les parties centrales de l'Amérique du Sud, Histoire du Voyage," Paris, 1850, Vol. II., p. 103. In describing the travels in the neighborhood of the city of Goyaz the author says:

On the night of the fifteenth in the vicinity of the Agoa Limpa estate we noticed a luminous mass in the middle of the campo that aroused our curiosity greatly. On approaching it we found it to be a termites' mound from which shone a great number of small points of light [petits foyers lumineux]. This phenomenon is produced by the presence of an immense number of small phosphorescent larvæ which withdrew into the galleries they had built when one tried to capture them.

The fact that I have lived and traveled in Brazil for ten years without ever having seen this luminosity at all; the surprise of Dr. Severiano da Fonseca at seeing a single instance in Matto Grosso; and the note by Castelnau, who traveled through tropical South America for four years, all lead me to surmise that this luminosity is probably confined to some particular species, or possibly to some special occasions or conditions of termite life.

J. C. BRANNER
STANFORD UNIVERSITY, CAL.,
December 13, 1909

CORRELATIONS OF CLIMATIC CHANGES

HAVING taken into consideration the yearly mean temperatures of 1891 to 1900, from all available sources, and after having discarded all doubtful records, I have drawn maps representing the geographical distribution of annual departures from the normal temperatures, the means of the ten years' observations being considered as normal values. On those annual maps I call thermopleions, or simply pleions, the areas occupied by positive departures, antipleions those of negative departures. The pleions and antipleions are bounded by the quasinormal line.

On this line the departures are nil, the values being equal to the ten-year means.

The lines of equal positive and negative departures I call hypertherms and hypotherms. The pleions represent inflections of the isothermal lines towards the pole, or, more properly speaking, towards the regions of colder climate.

The antipleions, on the contrary, characterize a local abnormal descent of the isotherms towards the equator.

The maps of successive years, for the same country and those of different countries for the same year, show remarkable correlations in the distribution of the departures.

A pleion, in most cases, exists during several years, moving from place to place. When one compares the different maps, and especially those of European and Asiatic Russia, one is led to believe that the pleions are produced by immense waves intercrossing. It seems that for the whole world, the years are either too warm or too cold following the predominance of pleions or antipleions. For example, the year 1893 was exceptionally cold, 1900 on the contrary was too warm. The temperature of the earth's atmosphere was at least one half a degree Centigrade higher during the year 1900 than during 1893. It is a notable fact that neither the Alps, the Caucasus nor the Rocky Mountains form barriers,

not even the Himalayas interrupt the progress of a pleion or an antipleion. This demonstrates the fact that the thermopleions and antipleions are products of temporary alterations of the general circulation of our atmosphere. A full discussion of the question of which this is but a short summary is to be found in my memoir "L'Enchaînement des Variations Climatiques," published recently by the Belgian Astronomical Society. I am working at present on the dynamical problems connected with the results I have already obtained and hope to be able, in a short time, to propose a method of research by which it will be possible to successfully predict, several months in advance, the climatic anomalies of the different seasons of the year. In connection with this study I intend to examine the yield of cotton and grain.

HENRYK ARCTOWSKI

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THE EFFECTS OF PROLONGED RAPID AND DEEP BREATHING

IN SCIENCE, December 3, D. F. Comstock calls attention to certain phenomena that follow upon a few minutes of enforced deep breathing. These phenomena, as he reports them, are in brief: (1) an apnœic pause, (2) mental stimulation, (3) increased physical endurance and (4) increased pulse rate.

Several years ago I published[1] the results of fairly extensive experiments upon the effects of forced respiration. A comparison of my results with those of Comstock may not be without interest.

In the first place, the apnœic pause is unquestioned. Some of my observers, without endeavoring to hold the breath at all, as did Comstock, furnished respiratory tracings in which two minutes of forced breathing was followed by two minutes of complete apnœa. A very common result was, however, not a pure apnœa, but a period of slow, shallow respiration with long expiratory phases.

Second, the immediate subjective effects of forced breathing were more or less dizziness, tingling and prickling sensations in the hands and feet, blackness before the eyes, and a feeling of confusion coupled with energy. There was often, too, a secondary experience of exhilaration.

Third, immediately after the cessation of forced breathing there was a noticeable improvement in strength and endurance of grip.

Fourth, a slight quickening of pulse occurred during the breathing, though not by any means so pronounced as that reported by Comstock.

Fifth, and most interesting: actual tests of reaction time, discrimination time, memory-span, visual discrimination of forms and precision of movement, all showed more or less impairment when administered immediately after forced respiration.

It is commonly stated that, while alcohol produces for a time distinct exhilaration and a feeling of exceptional mental readiness and fluency of thought, the actual performance under these conditions does not measure up to one's subjective estimate of it. I suggest, therefore, that, contrary to Comstock's view, forced breathing is probably not so valuable as a mental stimulant as it may appear on the strength of the feeling of exhiliration which it develops. My experiments, however, have no bearing upon the effect of forced breathing during longer intervals of time after normal breathing has been resumed.

GUY MONTROSE WHIPPLE

CORNELL UNIVERSITY,
December 6, 1909

[1] *American Journal of Psychology*, IX., July, 1898, 560–571.

QUOTATIONS

THE ANTIVIVISECTION CAMPAIGN

THE antivivisectionists so-called, that is, the misguided, ignorant, and the fanatics who have no objection to live-broiled lobsters, "live feather" pillows, spring traps for mice, sticky fly paper and other forms innumerable of torture of the brute creation, but shudder at the use of animals for the manufacture of vaccine and antitoxins or for the gaining of knowledge that will aid in saving human life, have opened their annual campaign by an attack on the Rockefeller Institute. A newspaper of this city, whose proprietor is said to have a

reason, though no excuse, for disliking medical men, has begun the publication of affidavits from discharged employees of the institute, picturing the "horrors" of animal experiments, particularly the epoch-making experiments of Carrel on blood-vessel anastomosis and the transplantation of viscera and other parts. It is made to appear that these are revelations of the secrets of the torture chamber, though all that these persons have to tell has already been told time and again in reports to societies and in the medical and other scientific journals, and even in the secular press. Among the horrors mentioned is that the experimenter after grafting a leg on a dog "twisted" it to see if the bones were knitting, and the impression intended to be conveyed is that the limb was turned round and round provoking howls of agony. An experimenter, no matter how "cruel" he was, would not be so foolish as to vitiate his experiment by breaking up the adhesions in this senseless way, and what he did, if he "twisted" the leg at all, was what every surgeon does with a fractured bone to assure himself that union is taking place. Another harrowing detail is that the dogs, when operated upon, under an anesthetic it is admitted, lost more or less blood. Still another is that when one of the operations failed and the dog was in pain he was chloroformed at once so that he should not suffer. And so with all the rest of this well-paid-for matter. The head lines are horrible, but any one of moderate intelligence, reading the affidavits and noting the character of the experiments and that they were always done under anesthesia, can see that they were conducted with no more "cruelty" than any surgical operation on man or beast. Many columns of equally hideous and bloody details could be written from the account of a scrubwoman or a day laborer who was allowed the run of the operating room and surgical wards of a hospital for a day or a week; and the surgeons who were racking their nerves and wearying their flesh in the endeavor to relieve pain and save life could with equal effect be called butchers in the stirring head lines.—*Medical Record.*

SCIENTIFIC BOOKS

Les Zoocecidies des Plantes d'Europe et du Bassin de la Mediteranée. By C. HOUARD, Docteur es sciences Lauréat de l'Institute. 2 vols., 1,247 pp., 2 full page plates and 1,365 figs. Librarie Scientifique. Paris, A. Hermann. 1908.

The plan of this work is especially interesting to botanists since the cecidia are grouped with reference to the host plants instead of the insects or other animals which cause their formation. The host plants are arranged in accordance with Engler & Prantl's "Pflanzenfamilien" and under each species is given the cecidia which occur upon it, with cross references for those species of cecidia which occur on more than one host. Each family of host plants is preceded with a résumé of the characters of the cecidia which occur upon its species. The work records a total of 6,239 species, with descriptions of each. In general, the descriptions are short and clear so that there should be very little difficulty in identifying the species. However, in some cases the data were evidently too meager to enable the author to give complete descriptions.

The figures are clear and for the most part have been copied from the works of the authors who described the species. Following each species of cecidia are the references to the bibliography. Each species is also accompanied by abbreviations which explain the part of the plant on which it occurs, whether it is simple or compound, whether the metamorphosis occurs in the cecidia or in the ground, the time required for its complete development, and the geographical distribution.

Among the host plants are many groups which in America, so far as we now know, have few or no cecidia, viz., the fungi, algæ, liverworts, mosses and ferns. There are also many families of flowering plants, of which the American representatives do not bear cecidia. About one third of the known genera of American cecidia are also common to Europe, but only a very few species are common to both the old and the new world. Of the few species which are common to both Europe

and America, the most conspicuous is the *Phylloxera vastatrix* Plan. of the grape which was introduced from America and has proved so destructive to the vineyards of Europe.

The work also includes a bibliographical index of nearly 400 authors and about 1,200 titles; index tables giving the orders, families, genera and species of the organisms which cause the cecidia; and the families, genera and species of the host plants.

In looking over the bibliographical index our attention is attracted to the names of a few authors who have also contributed to our knowledge of American cecidology, especially that of C. R. von Osten-Sacken, who contributed far more to the American than to the European literature.

Every one in America who has attempted a study of cecidology has experienced great difficulty due to the literature being so involved with other phases of biology, especially entomology, and the author in his preface states that this is also true in Europe and this fact has led to his undertaking this important work.

It will undoubtedly prove most useful not only for the cecidologist, but for the botanists and the entomologists. In fact, the author expresses the hope that the work will be of service to the entomologists, the botanists, the foresters and the agriculturists. The author and his fellow scientists are to be congratulated upon the excellency and usefulness of this work. A most excellent companion piece to this would be a similar work on the mycocecidies.

Cecidology is one of the youngest of the biological sciences in both Europe and America, but has attracted a great deal more attention in Europe than in this country. The greater part of the work has been done by the entomologists, who have naturally been more interested in the insects than in the cecidia. However, the subject is now attracting the attention of the botanists, who are finding it a fruitful field from the standpoint of plant pathology and plant physiology. There are at the present time a number of young workers who are taking up this study and in due time we may expect similar productions in this country.

MEL T. COOK
DELAWARE AGRICULTURAL EXPERIMENT STATION,
NEWARK, DEL.

Lehrbuch der Pharmakognosie. Von Dr. GEORGE KARSTEN, Professor an der Universität Halle, und Dr. FRIEDRICH OLTMANNS, Professor an der Universität Freiburg I. B. Zweite vollständig umgearbeitete Auflage von G. Karstens Lehrbuch der Pharmakognosie. Mit 512 zum Teil farbigen Abbildungen im Text. Jena, Gustav Fischer. 1909.

Pharmacognosy is a comparatively new branch of botanical science, and text-books on the subject are very welcome, particularly if they present a new point of view. In this country the so-called works on materia medica, on which the students of pharmacy and medicine formerly relied for their knowledge of vegetable drugs, are being replaced by works on pharmacognosy, on the one hand, and works on pharmacology on the other. In other words, these two divisions can no longer be covered by a single text or treated with authority by the same author. Thus, pharmacognosy in the modern acceptation of the term deals with the natural origin of vegetable and animal drugs, their physical and morphological characters, and the chemical nature of their constituents, while pharmacology deals with the action of their constituents and preparations on the animal organism, and hence to this latter division properly belongs the consideration of therapeutic properties and doses. It is to the credit of German scientists and teachers that they earlier differentiated these subjects than we in this country.

The work at hand treats of the vegetable drugs exclusively, but, like most of the German works on this subject intended for the use of students, treats only of a limited number of the drugs, these being more or less typical of the various classes. Professor Oltmanns has written the chapters dealing with the cryptogamic drugs, rhizomes, roots, tubers,

flowers and exudation products, while Professor Karstens has considered the woods, barks, leaves, herbs, fruits and seeds. The order of treatment of each drug is somewhat as follows: (1) The botanical origin together with a few words on the distribution of the plant; (2) an historical note on the use of the drug in medicine or in the arts; (3) the external morphology of the drug; (4) the anatomy of the drug; (5) a brief description of the drug in the powdered form, and (6) an enumeration of the important constituents.

The strongest feature of the work is the comprehensive treatment of the macroscopic and microscopic structure, the illustrations being numerous and in part colored. The German point of view of treating a selected number of subjects in a thorough manner is to be commended in a *Lehrbuch*, and looked at pedagogically Karsten and Oltmanns's "Pharmacognosy" is an excellent work.

HENRY KRAEMER
PHILADELPHIA COLLEGE OF PHARMACY

The Periodic Law. By A. E. GARRETT, B.Sc., F.R.A.S. New York, D. Appleton & Co.

This is one of the volumes in the International Scientific Series. The first part of the work is historical, after an introduction giving the methods of determining the atomic weights. Beginning with Prout's hypothesis, the early attempts at classifying the elements are reviewed. It may well be questioned whether undue space and prominence are not given to some of these. In discussing the periodic system itself, the author assigns more credit to Lothar Meyer than Mendeléeff was willing to give him and than I am inclined to think is justly his due. Much prominence is given the important work of Cornelley. The pendulum swing of Professor Spring, of Liége, is attributed to Reynolds and Crookes, and the idea of the spiral, first worked out by Baumhauer, is credited to Johnstone Stoney. A considerable portion of the book is given to the applications of the periodic law and a chapter is devoted to the efforts at stating the relationship between the atomic weights in the terms of a mathematical formula. In the last chapter there is a discussion of the more recent theories as to the nature and structure of the atom and their bearing on the periodic law.

The book is well written and should prove a useful handbook to a student of this important subject.

F. P. VENABLE

SCIENTIFIC JOURNALS AND ARTICLES

THE first number of the *Journal of Pharmacology and Experimental Therapeutics*, edited by Dr. J. J. Abel of the Johns Hopkins University, appeared in June. It contains the following articles, with these results in brief:

1. "The Comparative Toxicity of the Chlorides of Magnesium, Calcium, Potassium and Sodium," by D. R. Joseph and S. J. Meltzer. The order of toxicity of the four chlorides when tested on dogs is magnesium, Ca, K and Na. It is thought that the effect of these chemical substances depends in large part upon the particular substance upon which they act, that is, the effect upon simple tissues is not applicable to complex organs, and the effect upon organs is not applicable to entire animals. The toxicity of alkalies and alkali earths existing as constituents of the animal body is in inverse proportion to the quantities in which they are present in the serum of that animal.

2. "Studies in Tolerance—I., Nicotine and Lobeline," by C. W. Edwards. Tolerance to nicotine or tobacco can be obtained in animals only with great difficulty when the drug is given in small doses. Dogs develop resistance quickly to large toxic doses of nicotine, but to lobeline they gain only a limited tolerance.

3. "Studies in Tolerance—Strychnine," by Worth Hale. Dogs may develop a tolerance to strychnine very slowly and at best in a very imperfect form. Guinea-pigs, owing to their varying degree of sensitiveness, yield results that are somewhat uncertain, though acquired tolerance is suggested.

4. "Mechanism of Hæmolysis, with special reference to the Relation of Electrolytes to Cells," by G. N. Stewart. Evidence, both histological and physico-chemical, is brought forward to support the idea that the super-

ficial layer of the erythrocyte plays an important part in regulating the exchange between the corpuscles and the plasma or other surrounding media. Alterations of the envelope merely allow the conditions to be established which are necessary for the transformation of the hæmochrome. Some evidence is offered in support of the idea that the electrolytes of the erythrocytes may be divided into three fractions: (1) A portion which escapes even with the gentlest methods of laking, (2) one liberated only by energetic laking agents, and (3) one set free only by destructive processes.

5. "Studies Concerning the Iodine-containing Principle of the Thyroid Gland—I.," by S. Strouse and C. Voegtlin. Iodotyrosine has not an analogous effect to that of the extract of thyroid gland upon nitrogen metabolism or upon the blood pressure. It has no curative effect upon myxedema or cretinism, does not exhibit the typical action of the thyroid extract in exophthalmic goiter and finally the negative results of these writers seem to indicate that the activity of the iodine-containing principle of the thyroid gland is not due to a combination of iodine with one single cleavage product of protein.

6. "The Antagonism of the Adrenal Glands against the Pancreas," by C. W. Edmunds. The action of adrenalin in inhibiting the pancreatic secretion is found to be in no sense specific. Nicotine and other drugs that constrict the blood vessels of the gland cause an inhibition of the gland's secretion as does adrenalin, and in a similar manner asphyxia and splanchnic stimulation may produce anæmia of the organ and thereby inhibit secretion.

7. "Quantitative Experiments with the Cutaneous Tuberculin Reaction," by C. J. Pirquet. It is found that the cutaneous tuberculin reaction depends upon at least two factors, one the tuberculin, the other that furnished by the organism, which latter can be considered as an antibody, the origin of which dates back to previous infection of the organism with the tubercle bacilli. The first factor can be varied at will and progressive dilutions are followed by a more or less uniform diminution of the intensity of the reaction, but owing to an imperfect understanding of certain phenomena no definite mathematical expression could be elicited for the determinations made.

THE August number of the *Journal of Pharmacology and Experimental Therapeutics* contains the following articles:

1. "Some Convenient Laboratory Apparatus," by A. C. Crawford and H. Honn. An automatic winding device for spring kymographs is described and figured. This device consists of a small motor and a special clamp that can be easily attached to the heavier forms of kymographs resembling the Ludwig-Baltzer type.

A self-registering injection, a nerve stimulating apparatus, and a combined signal and base line apparatus are each figured and described.

2. "The Effect of Caffeine and Sodium Bicarbonate upon the Toxicity of Acetanilide," by Worth Hale. The author concludes that caffeine is of little or no benefit in acetanilide poisoning, in some cases it even exerts a harmful effect. Sodium bicarbonate lessens the toxicity of acetanilide both upon the heart and upon the intact animal.

3. "Anesthesia by the Intracerebral Injection of Magnesium Chloride," by V. E. Henderson. A note describing a laboratory method for anesthetizing rabbits and cats.

4. "Ergot," by W. H. Cronyn and V. E. Henderson. It is held by these writers that most galenical preparations contain considerable amounts of the active principles. The pharmacologic action of the small doses usually prescribed are, however, too slight to elicit the desired effect when given *per os*. Ergotoxine is a highly active alkaloid and has the properties of ergot most desired in medicine, it brings on long enduring vaso-constriction, increases uterine movements when exhibited intravenously, and the same to a less extent when injected subcutaneously, but when given *per os* has very little action.

5. "On the Pharmacological Action of Some Phthaleins and their Derivatives, with Special Reference to their Behavior as Purgatives—I." by J. Abel and L. G. Rowntree.

Phenolphthalein and its halogen products, phenoltetrachlorphthalein and tetrabromphenoltetrachlorphthalein do not differ markedly in their pharmacological behavior. Both phenolphthalein and its tetrachlor derivative are non-irritant when applied to the mucous membrane, to open wounds, and when injected subcutaneously. A subcutaneous injection of 0.40 g. in man causes a laxative action lasting four to six days. This prolonged action along with its low degree of toxicity makes it a hypodermic purgative of much promise. When subcutaneously injected the tetrachlor derivative is absorbed and finally excreted into the bile only. Phenolphthalein administered in the same way escapes in part in the urine, when given *per os* it may appear in small quantities in both bile and urine, but when the tetrachlor compound is given by mouth none of it appears in the bile or in the urine. The large intestine may absorb these drugs from their solution in bile and become thoroughly saturated with them.

6. "Clavin, Vahlen's Active Constituent of Ergot," by D. Vanslyke. A sample of Vahlen's "clavin" showed upon analysis the following content: leucin, 39.1, iso-leucin, 22.3, and valin 37.1 per cent.

7. "The Effect of Collodion on the Amanita-hemolysin." Amanita-hemolysin when dialyzed in collodion sacs loses its hemolytic action completely. Likewise when in contact 24 to 36 hours with granular collodion previously boiled in one per cent. sodium chloride solution and washed with dilute alkalies the hemolysin loses its hemolytic action. Solanin is not affected, but saponin sometimes is.

8. "The Distributions of Poisons in the Amanitas," by W. W. Ford. Nearly twenty species of amanitas were examined and the three most important poisons found in these fungi are muscarine, hemolysins and toxins. By the methods used even one or two plants furnish sufficient analytic material to establish the properties of the fungus suspected of being poisonous.

9. "On the Pharmacological Action of Iodiodoso- and oxyiodosobenzoic Acids," by A. S. Lovenhart and W. E. Grave. Intravenous injections of N/20 solutions of sodium iodosobenzoate or oxyiodosobenzoate acids cause an immediate and marked depression of the respiratory center, which seems to be identical with ordinary apnœa caused by excessive ventilation. This and other physiological phenomena seem to indicate that the oxygen bound to the iodine in iodosobenzoic acid is physiologically active.

AN EARLY NOTE ON FLIES AS TRANSMITTERS OF DISEASE

In these days when we are just coming to realize what powerful agents insects are in the dissemination of infectious diseases, it is interesting to read on pages 385 and 386 in Edward Bancroft's "An Essay on the Natural History of Guiana in South America," published in London in 1769, concerning a disease called "Yaws" very prevalent in Guiana:

> The Yaws are spungey, fungous, yellowish, circular protuberances, not rising very high, but of different magnitudes, usually between one and three inches in circumference. These infest the whole surface of the body, and are commonly so contiguous that the end of the finger can not be inserted between them; and a small quantity of yellowish pus is usually seen adhering to their surface, which is commonly covered with flies, through the indolence of the Negroes. This is a most troublesome, disagreeable disorder, though it is seldom fatal. Almost all the Negroes, once only in their lives, are infected with it, and sometimes the Whites also, on whom its effects are much more violent. It is usually believed that this disorder is communicated by the flies who have been feasting on a diseased object, to those persons who have sores, or scratches, which are uncovered; and from many observations, I think this is not improbable, as none ever receive this disorder, whose skins are whole; for which reason the Whites are rarely infected; but the backs of the Negroes being often raw by whipping, and suffered to remain naked, they scarce ever escape it.

The "Yaws" according to the Standard Dictionary is: "A contagious tropical skin-disease characterized by small, dusky red spots that develop into raspberry-like tubercles, sometimes ulcerating: often of long continuance: frambœsia."

Bancroft was a physician, who resided on the river Demerara, from which he wrote letters to his brother under dates July 8–November 15, 1766. In 1769, these letters were collected and published in a volume, under the above title, dedicated to William Pitcairn, M.D., fellow of the Royal College of Physicians in London and Physician of St. Bartholomew's Hospital. The copy from which this extract is taken may be found in the Library of Congress at Washington.

E. W. GUDGER

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SPECIAL ARTICLES

GLACIATION IN THE SAN BERNARDINO RANGE, CALIFORNIA

WHILE engaged in the study of the mountains of southern California the past summer the writers spent a week about the slopes of San Gorgonio Mountain, the highest point of the San Bernardino range. The important discovery was made of unmistakable signs of former glaciation upon its northern slope. This is a fact of considerable interest because it has hitherto been assumed that the southernmost point of glaciation in the United States was in the Sierra Nevadas, nearly two hundred miles to the north.

The San Bernardino range is topographically distinct from any other mountains of southern California. It appears to be much younger than the San Gabriel range, from which it is separated by the Cajon Pass, and also to have had a different history from the San Jacinto Mountains, which lie to the south on the opposite side of the San Gorgonio pass.

The topography of the range is marked by broad elevated valleys, and plateau-like ridges. There are several undrained basins quite similar to those in the desert immediately adjoining on the north, and it seems reasonable to assume that the range as a whole is an uplifted fault block of what was once topographically a portion of the Mohave desert.

The highest portion of the range forms a rather sharp ridge about six miles long and extending a little north of west and south of east. San Bernardino Mountain forms the western end of this ridge with an elevation of 10,630 feet, while the eastern end is known as San Gorgonio Mountain with a height of 11,485 feet. The Santa Ana River, the main stream in the range, drains the northern slope of this ridge, receiving its large permanent flow of cold water from the glacial gravels and the snow banks which linger late in the season in the heads of the protected cañons.

The largest glacier existed on the northwest slope of San Gorgonio in a semicircular basin made by a northerly curve of the ridge running westerly to San Bernardino Mountain. Here is a true glacial cirque, and from its margins well-characterized morainal ridges extend downward for about a mile into the basin of the South Fork of the Santa Ana River, and block a small tributary from the east. Above the dam thus made is a body of water about a quarter of a mile across known as Dry Lake. The lower marginal moraine reached fully three quarters of a mile below the lake, the total width of the glacier at its lower end being indicated by this distance. The rock débris on its lower side forms a great wall across the valley 300 to 400 feet high. The glacier appears to have been overloaded with débris and after having first reached the lowest point where there is a great quantity of partly modified morainal material, to have been crowded progressively eastward back toward the present Dry Lake. In places two to three marginal moraines appear and several basin-like depressions resembling kettle holes. No bedrock is visible in the path of the glacier and scratched boulders were not recognized with certainty. The granitic rocks are coarse and crumble rapidly and it is not to be wondered at that no boulders thus marked were seen. Great springs issue from the lower margin of these glacial gravels, forming a typical mountain meadow with abundance of grass and a cool bracing air.

Another typical cirque basin lies close up under the northeast crest of San Gorgonio, and contains snow drifts nearly all summer.

A half mile below are one or more well-marked semicircular terminal moraines.

Two miles northwest of San Gorgonio, and in another northeastward facing cirque was a glacier which carried down a vast amount of débris to within a quarter of a mile of the termination of the large glacier already described. A small body of water known as Dollar Lake occupies the last resting place of the ice close up under the rocky cliffs.

Following the ridge westerly for two miles more we come to a cirque-like basin close up under the crest and forming the head of Hathaway Creek. Here was perhaps the most interesting glacier of all in the district. It was a long narrow tongue of ice which reached downward a mile and left the most perfect moraines seen. Five semicircular terminal moraines cross the cañon and upon its eastern side is an ideally perfect marginal moraine. The middle one of the terminal moraines is formed of immense blocks of rock and looked at from below its curving front forms a great wall nearly 100 feet high. The lowest moraine, 1,000 feet farther down the cañon, is formed of the finest material of any, as though when the first ice tongue came down it found the surface soft and deeply disintegrated. The phenomena here indicate that glaciation was of considerable duration, and that the history of the period was anything but simple.

The last glacier on the ridge was a small one nestling also in a northeast-facing alcove near the top of San Bernardino Mountain.

None of these glaciers appear to have descended much below 8,500 feet, and it will be seen from the descriptions given that the conditions had to be just right for their appearance at all. Such conditions were a northward or northeastward facing alcove which headed sufficiently close to the crest to receive the snows which drifted over its summit. The west fork of Hathaway Creek, which headed nearly as high as the glaciated one, was separated from the crest by a plateau-like shoulder and in its sharp V-character appears never to have contained anything of a glacial nature.

There seems to be no other possible interpretation of the phenomena observed but that of glacial action, and it is quite remarkable that this extensive lofty region known to have a heavy precipitation and to contain a boreal fauna and flora should not long before have been investigated in regard to the possibility of its having been glaciated.

H. W. FAIRBANKS,
E. P. CAREY
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MALLOPHAGAN PARASITES FROM THE CALIFORNIA CONDOR

THE great vulture or condor of California, *Gymnogyps californianus*, although not as rare a bird as reported by most bird books is yet so uncommon and shy, and hence so rarely seen, and is such an extraordinary great feathered animal, that it is one of the most interesting of American birds. It ranges north and south through the mountains of the state, nesting in wild and inaccessible places. It is nearly, if not quite, as large as the condor of the South American Andes, averaging four and a half feet in length and ten feet in spread of wing. The female lays a single enormous egg (4½ x 2½ inches), specimens of which are rarer in collections than those of the great auk.

Up to the present time no Mallophaga (biting bird lice) have been recorded from this bird giant. However one of my students of several years ago, C. S. Thompson, a student of birds as well as of insects, took a number of Mallophaga from a single condor and I have just taken time to go over this material. It includes only two species, a small *Menopon* and a *Lipeurus* of average size.

The *Lipeurus* belongs to the well-characterized group of sex-guttati (with six curious chitinized spots on the anterior half of the head), whose members are found only on raptorial birds, especially the larger kinds as vultures and eagles. The group affinities of the specimens (two females and a male) are certain, but whether they should be assigned to one of the few already described species of this group or be looked on as representatives of a new form is not so easily determined.

On the whole, I am inclined to align them with Giebel's long-known species *Lipeurus assessor*. Giebel described the species from specimens taken from the South American condor, *Sarcorhamphus gryphus*. Piaget found it again on the same host and Carriker has taken it on the king vulture, *Gypagus papa*, in Costa Rica. As the range of the king vulture and the California condor almost overlap (the king vulture is said to occur occasionally in Arizona) it is, at first thought, not surprising that the single parasite species is common to all three of these great American vultures.

Osborn has found a *Lipeurus* on the turkey buzzard (*Cathartes aura*) in Iowa, but describes is as distinct from *assessor* under the name *marginalis*. His specimens (two) are smaller by a third than *assessor* and have their markings "confined to the narrow marginal lines."

The single *Menopon* specimen, a female, can also, I think, be ascribed to an already known species, namely *Menopon fasciatum*, collected by Rudow from the South American condor (*Sarcorhamphus gryphus*) and by Carriker from the king vulture (*Gypagus papa*). The exact determination of this *Menopon* species is made very difficult, if not impossible, by Rudow's incomplete description, but Carriker's figure and what there is of the original description correspond too well with my specimen from the California condor to make necessary the establishment of a new species for it.

It is highly interesting—at least it is to me—to find two parasitic species common to all three of the great vultures of the American Cordillera. But the range of these birds, although extending north and south for several thousand miles, is nearly continuous when the three species are taken as one host type. Looked at in this way the geographical range of the parasites seems explicable. But when we keep in mind the facts that the host type is really a compound of three taxonomically quite distinct units—they represent three separate genera to the ornithological systematist—and that the individuals of each of these host units are particularly non-gregarious, even solitary, birds, preventing, almost certainly, any actual bodily contact between individuals of the different species and, except at mating and nesting time, any such contact even among individuals of any one of the species—when we face these facts the distribution of these wingless parasite species comes to assume the interest and importance of a problem. What is its solution?

I can simply reiterate my belief, already several times previously declared, that such cases can only be explained on the assumption of the occurrence of the parasite type on the common ancestor of all three of the related (although generically distinct) host types, and its persistence practically unchanged on each of the diverging descent products from this original ancestor-host.

Vernon L. Kellogg
Stanford University, Cal.

FUR-SEALS DOMESTICATED

Until a few months ago, no authentic instance was on record of Alaska fur-seals (*Callorhinus alascanus*) being fed in captivity and living for any length of time in other than their natural environment. Apocryphal tales exist on the Pribilof Islands of fur-seals having been tamed and living thereafter in the habitations of human beings on the islands. In the early seventies, the Alaska Commercial Company placed two immature live fur-seals, exact ages not definitely known, in Woodward's Gardens in San Francisco, which were confined within an enclosure, and which died of starvation after several months' incarceration, having eaten nothing during the interval.

This experiment at Woodward's Gardens fixed the idea that fur-seals would not feed in captivity. In view of this belief, it is specially interesting to announce that Mr. Judson Thurber, boatswain on the revenue cutter *Bear*, has succeeded in inducing two fur-seal pups to take food voluntarily and in keeping them alive and well in captivity from October 9, 1909, until the present time. A brief account of this successful experiment is given.

The effort had its inception in the desire of

Dr. Fox, the surgeon of the *Bear*, to ascertain whether the fur-seal carried ectoparasites. For this purpose, a starving fur-seal pup, whose mother had been killed while feeding at sea, was given to the *Bear's* surgeon, who was unable to discover any of the parasites mentioned. The half-starved little animal was then taken by Mr. Judson Thurber, the *Bear's* boatswain, who desired to attempt feeding the pup by artificial means. He was so far successful in his efforts that he induced this pup to eat dried fish from his hand and kept it in good condition for three weeks, when it died in convulsions. Desiring to carry the experiment farther, Mr. Thurber obtained two well-conditioned fur-seal pups, a male and a female, from the Pribilof Islands on October 9, which he induced to eat regularly and even greedily, and which now are fat and in prime condition.

The chronology of the experiment follows:

October 9.—Two pups delivered to Revenue Cutter *Manning*.

October 14.—Pups delivered by *Manning* to *Bear*—did not eat between these dates.

October 19.—Female began eating solid fish.

October 23.—Male chloroformed and frenum severed.

October 28.—Male induced to swallow a little dried salmon.

November 2.—Male began to eat at will, and on that date ate with evident relish nine small fresh herring at Seattle.

Mr. Thurber began his experiments by forcing condensed milk down the throat of the starving pup first obtained. In doing so he discovered that the animal experienced difficulty in swallowing and attributed this to the fact that the movement of the tongue was restricted by the frenum. This Mr. Thurber at once severed forcibly with his finger, upon which the pup soon after began to eat fish. After the death of this pup and his securing the two others, the same impediment to the free movement of the tongue was noted. The female, it is stated, succeeded in breaking the frenum by her own efforts and a few days afterwards began to eat. The male being unable to do this, on October 23 he was chloroformed and his frenum cut. Immediately after this, the male began to protrude its tongue and to nose the fish in its enclosure, but did not eat, possibly because no suitable food was obtainable at sea. Upon the arrival of the vessel at Seattle small herring were fed to the pups and both animals ate greedily.

The female was by far the easier to feed, was without food for only ten days and has been in good condition during the whole of her captivity. The male, however, was virtually without food from October 9 until November 2, a period of twenty-four days, during which time he grew thin rapidly and was a pitiful sight beside his fat and sleek-looking companion. Since he began feeding, however, he fattened daily and now is as well-conditioned as the female.

The pups have been kept on board the *Bear* in a box six feet long by three feet wide. At first this box was filled with sea-water two or three times a day. Now the box is kept filled with water during the day and is emptied at night. They manifest no desire to leave the water during the day and frequently sleep on the surface. In the morning, when the box is filled with water, they show every indication of delight. They are very tame and, when not in the water, will allow any one to fondle them unless a quick motion is made, when they will snap, but even then will bite gently if the hand is allowed to remain quiet.

In conducting this experiment Mr. Thurber used great patience and no little skill. He began feeding the animals by holding their mouths open and pouring into their mouths evaporated cream mixed with bits of fish. The pups resented this, but small quantities went into their stomachs. Later, Mr. Thurber would tie bits of fish on the end of a string and tease the animals until they would snap at the fish. Then he would manage to poke the fish down the seal's throat and cut off the string. In this way the female was taught the taste for fish, after which she soon learned to eat voluntarily.

These animals, the only captives of their kind in the world, are now thriving on board the *Bear* and it is hoped soon to bring them to Washington, where they will be placed in the large pool at the Bureau of Fisheries. Mr. Thurber is entitled to all credit for his suc-

cess in demonstrating the practicability of a measure hitherto believed impossible of accomplishment. The greater portion of the foregoing data was furnished by Captain E. P. Bertholf of the *Bear*.

The result of Mr. Thurber's experiment is to establish the possibility of feeding fur-seals in captivity. Incidential to this is the interesting disclosure seemingly demonstrated by three examples under observation that the frenum in the fur-seal young at first opposes an obstacle to their taking solid food, and that its rupture is a prerequisite to their feeding on other substances than mother's milk. Should this be proved by subsequent experimentation, the knowledge may open up a wide field of endeavor, having as its object the saving from death of those fur-seal nurslings whose mothers have been killed at sea, and which now die a lingering death from starvation.

BARTON W. EVERMANN,
WALTER I. LEMBKEY
BUREAU OF FISHERIES,
WASHINGTON, D. C.

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 462d meeting was held November 27, 1909, with President Palmer in the chair.

Mr. A. S. Hitchcock referred to the many changes in nomenclature in recent years, and pointed out that much of this change was inevitable. He illustrated the changes that must follow from increased knowledge of the history of grasses, by examples from Otto Kuntze and showed how some of Kuntze's conclusions were nullified by an early paper by Rafinesque.

Professor Bartsch, referring to a recent paper by Professor Spillman, called attention to the attempts of Mr. D. H. Talbot, of Sioux City, Iowa, during the eighties to breed a solid-hoofed hog in order to overcome the foot disease. Hog cholera carried off all but two of the selected animals which had only partially solid hoofs. From the progeny of these by selection and breeding a race of solid-hoofed hogs was obtained, specimens of which were seen by the speaker in the early nineties.

The chair called attention to the consummation of what may be considered the first international game preserve. This preserve consists of two separate reservations—one established by the state of Minnesota and the other by the province of Ontario. These two reservations adjoin the international boundary. For several years a bill to establish a game refuge in northern Minnesota has been pending in Congress but has failed to pass. Last February by proclamation of the President the Superior National Forest was established in Minnesota, and shortly after a bill was passed by the state legislature prohibiting the hunting of game animals or birds in national forests, state parks and such other lands in the state of Minnesota as the game commission might set aside as game refuges. Under this law the Superior State Game Preserve, comprising about 1,000,000 acres, and including all of the Superior National Forest and some other lands adjoining the international boundary, has recently been established. Still more recently the province of Ontario has set aside an equal area as the Quetico National Forest immediately adjoining the Minnesota reservation on the north. The combined area of the two reservations is about 2,000,000 acres.

Mr. Howell described a case of semi-domestication of a wild bird, the myrtle warbler, in the drug store of Union Station at Washington. Mr. H. W. Clark noted a somewhat similar instance at Lake Maxinkuckee, Ind., in 1906.

The following communications were presented:

Observations on the Mammals of the Mammoth Cave: A. H. HOWELL.

The paper gave the results of a visit to the cave in late June and early July. The habits of the cave rat (*Neotoma pennsylvanica*) were described and specimens exhibited which had been captured in the cave. Mention was made of the occurrence of three species of bats in the cave in winter; none is found there, however, during the summer months.

The Distribution of Color in the Seeds of Cowpeas: C. V. PIPER.

In the seeds of cowpeas, the following colors are met with where the seed is uniformly colored: black (really very dark violet), violet, maroon, pink, buff, cream, white, marbled brown and buff, speckled blue on buff. In many varieties of cowpeas, however, especially where the body is white, the other color is always distributed in definite types: (1) *Small-eyed* with a small amount of color about the hilum. (2) *Large-eyed* with a large amount of color about the hilum. (3) *Saddled* with a very large amount of color cen-

tering about the hilum. (4) Like (2) or (3), but the color extending over the strophiolar end of the seed. (5) Like (4), but in addition scattered isolated spots. (6) The whole seed colored excepting a small area at the micropylar end. These types of distribution are identical for all the colors, and in this respect the marbled and speckled colors act like simple colors; for example, a cross between whippoorwill, a marbled seed and black eye gives a white seed with a marbled coloring about the eye. It is evident from what hybridizing has been done and the varieties already in existence that there are perfectly definite factors determining the color distribution, the exact details of which will require much further investigation. It is suggestive that the coloring centers about the eye and in the different types extends farther and farther morphologically from the eye, the last part of the seed remaining white being the micropylar end. This is apparently in accordance with the path of nutrient substances entering the seed as the micropylar end is both morphologically and physiologically farthest from the hilum. The distribution of color in the cowpea is much simpler and quite different from what it is in the beans, which have been more carefully studied. In the case of some cowpea hybrids, one color pattern seems to be laid directly over the other as in crosses between marbled and speckled varieties, which results in hybrids having both the marbling and the speckling.

A Painful Skin Disease in Man Caused by a Predaceous and Supposedly Beneficial Mite: F. M. Webster.

Attention was called to epidemics of a dermatitis due to a small mite (*Pediculoides ventricosus*) in various parts of the country. In the east, the presence of these mites among wheat straw was traced to the abundance of the larvæ of the Angoumois grain moth, while in the middle west, its excessive abundance was due to the presence of a wheat joint worm (*Isosoma tritici*).

As wheat straw is used largely in the manufacture of a cheap grade of mattresses, people using these mattresses had experienced painful eruption caused by the mites escaping from the straw and attacking the occupants of the beds on which the mattresses were used. In the middle west, people handling wheat straw, either in thrashing the grain or in bales, had been attacked and suffered from the attacks of the mites. Owing to the fact that this eruptive skin disorder affected whole families, it has been heretofore supposed to be contagious.

M. C. Marsh,
Recording Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

At the 436th regular meeting of the society, held in University Hall, George Washington University, November 9, 1909, Dr. Edgar L. Hewett, director of the American School of the Archæological Institute of America, gave an account of the work of the school during the past years. The lecture was illustrated with stereopticon views. Dr. Hewett first described and illustrated the work of the Utah Branch, in immediate charge of Professor Byron Cummings, of the State University of Utah. He threw on the screen views of the large natural bridge and of the two great cliff houses lately discovered on the Navajo National Monument, northern Arizona. Archeological work is now being done on the ruins on this reservation. He showed also the method of work and the results obtained in excavations conducted by the American School at Puye and Rito de los Frijoles, in New Mexico. Excavations at the former place included work on the large community house on the mesa, and on the cliff-dwelling at the base of the cliff. He explained the relation of the casas and the rooms built on top of the talus in front of them.

"The ancient remains of the Rito," said Dr. Hewett, "consist of four community houses in the valley and one on the mesa rim near the southern limit of the cañon, and a series of cliff houses extending for a distance of a mile and a quarter along the base of the northern wall." The excavation at the Rito revealed a type of ruin called a talus village; thirteen of these ruins were recognized.

The field work of the school includes not only excavation of ruins, but also repair of their walls and in some minor cases restoration.

Views were shown of the community house on top of the mesa at the Rito, the trail worn to the summit, an excavated kiva, a restored ceremonial opening, a secular room provided with a fireplace and another with a mill (restored) for grinding corn. It is contemplated to place in the excavated rooms the more common domestic articles found in them, so that in a field museum of this kind these may be viewed in their proper setting.

At the 437th regular meeting, December 7, 1909, Dr. J. B. Clayton gave an illustrated lecture on "Varying Values of the Cross Symbol."

In common with other universal symbols the cross emblem presents four clearly marked stages in its development, a simple idea, elaboration, sanctity and decadence. The crux ansata of Egypt, which was originally a water gauge beginning with a simple stick set upright on the banks of the Nile to indicate the height of the annual overflow, was elaborated, first, by the addition of a short horizontal bar, thus forming a tau-cross, the masculine symbol sacred in Phœnicia to Tammuz, and later by the sun-circle, finally changed to a loop, making the object a handled cross. Thus juxtaposed, the fertility of sun and waters suggest the generative powers of nature. This symbol appears in the catacombs with the sun circle transformed into a laurel wreath, expressive of the triumphant faith and hope of christians. The first historical appearance of the swastika, fourteenth (?) century B.C., is apparently on a small leaden figure three and a half inches long, found by Dr. Schliemann in the second city of the ruins of Troy together with many crosses of gold, silver, etc., the location of the symbol on the figure having generative significance. The swastika indicated the sun—the feet referring to the rays, then fire and finally life. In India, the swastika (arani) formed by the two firesticks—the feet indicating flames—was the emblem of fire, then, by an association of ideas, the flame of being. Thor's hammer, identical in form with the Phœnician masculine cross, was the sacred symbol of fire, the hearth, marriage and fertility, and in the god's use of this hammer to restore his two dead goats, the symbol suggests immortality. The paper traced the gathering of various national crosses by the early converts to the catacombs of Rome, where the crux ansata, swastika, tau-cross and modifications of them all, appear on the walls and tombs. The wave of enthusiasm occasioned by the discovery of America brought many missionaries across the Atlantic—following the reports of those who took possession of the soil under the sign of the cross—and they were amazed to find the cross already so prevalent, attributing its presence to some early christian missionary, traditionally St. Thomas. Its use on altars, tablets and pottery, in weaving, in ceremonies, as well as in representing the orientation of the earth and the heavens, the material and the invisible world, were suggested in support of the thesis that whether as swastika, emblem of fire, wind or water, crux ansata emblem of reproduction, the tau-cross suggestive of the masculine function, or the Latin cross with its acquired ethical suggestion, the cross has always been the generic symbol of the impartation and maintenance of life.

JOHN R. SWANTON,
Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE fifty-seventh meeting of the society was held at the Dewey Hotel, November 26, at eight o'clock P.M., Vice-president Spillman presiding. The following papers were read.

Maize and Pellagra: Dr. C. L. ALSBERG.

A description of the clinical features of pellagra was presented, its history in Europe sketched and its occurrence in North and South America discussed. The different hypotheses in regard to its etiology were considered, viz., the malnutrition theory, the spoiled maize theory and the work of Lombroso, the mold theory and the work of Ceni, the bacterial theory, and the protozoon theory. It may be said that pellagra occurs where spoiled corn forms the most important feature of the diet of wretchedly poor peasantry, that most investigators believe it to be an intoxication by as yet unidentified toxic products of the growth of lower organisms upon corn, and that this belief has not as yet been established beyond doubt. In the United States sporadic cases have probably existed for many years. Its apparent increase of recent years may, if the spoiled corn theory be correct, be due to climatic and agricultural changes leading to change in varieties of corn grown, to harvesting of more immature corn, and to imperfect curing, all factors which may favor spoiling. The industrialization of the south with the resultant consumption of corn shipped long distances and the disappearance of the small neighborhood grist mill, may be further factors. Deterioration of corn is usually due to its great moisture content, when harvested prematurely or imperfectly cured. The remedy is to cause it to be thoroughly dried, preferably in kilns, before it leaves the farmer. This would not merely be an important hygienic measure but an equally important economic one. The saving of freight charges would be enormous, for many millions of gallons of water in the form of unnecessary moisture are hauled annually from the corn-belt to the seaboard.

The Relation of Plants to Peat Formation: Professor CHARLES A. DAVIS.

A short account of two important types of peat deposits and ecological relations of the plants from which they are formed.

The chief agents of decomposition of vegetable

matter are aerobic organisms, principally plants; anaerobic forms being much less active and seemingly wanting in many peat beds. Over most of the United States, peat is formed only where the ground-water level is above or very near the soil surface, because it is only through saturation that the air and the more actively destructive organisms are excluded and vegetable accumulations partially preserved. The numbers and kinds of anaerobic organisms and the decomposition resulting from their activities seem also to be reduced by the presence of gases like hydrogen sulphide and methane and of colloidal and soluble poisonous substances resulting from the decomposition in progress. Most peat beds show a much greater amount of decomposition above the water level than below it.

The two types of peat deposits discussed were those formed (1) in depressions below the ground-water level, ponds and lakes; (2) where the soil surface was at or slightly above the ground-water level, poorly drained flat areas.

In (1) the major part of the material is laid down under water through the growth of aquatic plants. These are primarily governed in the depth to which they can grow below the water surface by the distance to which enough light can penetrate for the minimum requirement to enable them to establish themselves. Few species reach twenty feet even in clear water, and this is reduced by any suspended or dissolved colored matter. Peat formation is slow at maximum depths at which plants grow, and more rapid in shallower water—hence the deposits often take the form of terraces, with steep outer faces. The peat at different depths is chiefly or wholly formed by definite plant associations that arrange themselves zonally around the open water, according to their tolerance of poor light, low temperature and other unfavorable conditions. Free-floating plants of all types may form additions to any part of deposits or make up a large part of any given one.

When the surface of the accumulated débris rises nearly to the level of the water, turf-forming plants may invade it and form a permanent cover. Shrubs, coniferous trees and sphagnum moss may establish themselves when the surface is about a foot above the permanent water level, and the latter may then build up the deposit for a few feet. The sphagnum-covered peat bed is more common at the north than in the south, where shrub and tree-covered deposits are more common.

The plants that form peat beds on flat areas are those able to endure excess of water, and probably toxic substances about their roots. Those found in a particular locality will depend on the permanent relation of the ground-water level to the soil surface, and may be mosses, sedges, grasses, shrubs or trees, or mixtures of all these. If the water level rises as the peat accumulates, as seems often to happen, the same plant associations may form the entire deposit. If the peat builds faster than the water level rises, the significant plants will change until a forest association is developed.

If the water level rises faster than the peat, pond conditions may be developed. In any case, peat beds will be of homogeneous structure only where the water level rises with the peat, and it is only on such deposits that the plant association growing on the surface is significant of the structure and quality of the peat below.

W. W. STOCKBERGER,
Corresponding Secretary

THE TORREY BOTANICAL CLUB

THE meeting of October 27, 1909, was held at the New York Botanical Garden and was called to order at 3:30 P.M. by Dr. E. B. Southwick.

About forty persons were present. After the reading of the minutes of the preceding meeting, the scientific program was presented, the first contribution being made by Mrs. N. L. Britton, who spoke on "Arctic Mosses." The speaker's remarks were based on studies of mosses sent from the American Museum of Natural History to the New York Botanical Garden for determination. They were collected by Commander Robert E. Peary in Grant Land in 1902, and by Dr. L. J. Wolf at Wrangle Bay, Lincoln Bay and Grant Land in 1906. The Peary collection includes 62 bryophytes, of which 57 were mosses, representing 24 genera, and 5 were hepatics.

Specimens of flowering plants were also exhibited which have recently been acquired by the New York Botanical Garden through the courtesy of the Peary Arctic Club from the American Museum of Natural History.

The collection consists of herbarium specimens made on the late expedition of Commander Peary to the North Pole and were collected mostly by Dr. J. W. Goodsell. While some of these were obtained on the northern coast of Labrador, the majority were collected on Grant Land, in the northern portion of Ellesmere Land, an island off the coast of Greenland. One of the packages contained specimens from perhaps the most northern

locality where flowering plants have ever been found, while another is from Etah, the most northern habitation of man.

Since the subject of mosses was the principal topic of the hour, Dr. Murrill referred briefly to the genus *Dictyolus*, the species of which are found on living mosses. This genus belongs to the Chanterleæ, a tribe of gill-fungi, and there are only two species known in North America, *D. muscigenus*, occurring from Greenland to South Carolina, and *D. retirugus*, known from Greenland, Alaska, Minnesota and California. Both species are small and thin, grayish or brownish in color and have folded-like gills. *D. muscigenus* may be recognized by its distinct stipe and dichotomous gills, while *D. retirugus* is sessile or subsessile with branched, reticulate gills.

Dr. N. L. Britton spoke of the three genera of Cactaceæ, *Carnegiea*, *Pachycereus* and *Cephalocereus*, and showed specimens of their flowers. The genus *Carnegiea*, dedicated to Mr. Andrew Carnegie and formerly known as *Cereus giganteus*, consists of a single species. Some of these plants attain a height of sixty feet and branch at from twelve to twenty feet above the ground. The flowers are funnelform with a nearly cylindric tube, bearing a few broad triangular scales. *Pachycereus* blooms at a different season from *Carnegiea* and the perianth tube is clothed with woolly hairs and bristles.

Cephalocereus, which has many representatives in the West Indies and some in Mexico, derives its name from the fact that the top of the plant is hairy. At Key West, Florida, there is a colony of *Cephalocereus keyenses* which is related to some of the Cuban and Bahaman species. It is the only locality where this species is known to exist. As it is growing here on a government reservation, it will most likely be preserved.

Mr. Roland M. Harper told of his experiences in the south from July, 1908, to July, 1909. A few weeks were spent at the Biltmore Forest School, North Carolina. Specimens were observed here of *Helonias bullata* and *Dalibarda repens* which are not listed in Small's "Flora of the southeastern United States." The former was reported several years ago by F. E. Boynton, while the latter was first noticed by Dr. Homer D. House.

Six weeks were spent in Georgia, particularly in the vicinity of Pine Mountains and among the sand-hills of the fall line region, where he found *Chamæcyparis thyoides* which has not previously been reported from the state. Specimens of *Chrysopsis pinifolia*, discovered by Elliott in 1815, and known only from one county, were collected, and also a twining *Bartonia*. Together with a party of geologists, Mr. Harper made a trip of 260 miles on the Warrior and Tombigbee rivers in Alabama, which occupied a period of ten days. Here he collected an *Equisetum* which resembles *E. arvense*, but is several hundred miles out of the range of that species. While in Florida studying peat for the state geological survey, he found several interesting plants, *Spartina Bakeri*, which is very common but not mentioned in any flora, and an arborescent *Serenoa serrulata*, some plants of which attained a height of ten feet, and an undescribed species of *Prunus*. Mr. Harper explored the southern end of the everglades, following about the same route as that taken by Dr. Britton in 1904 and Dr. Small in January of this year.

Dr. Southwick reported the finding of *Viola pedata* in flower, October 25.

The meeting of November 9, 1909, was held at the American Museum of Natural History with Vice-president Barnhart in the chair. Eighty-nine persons were present.

The scientific program of the evening consisted of a talk by Dr. Marshall A. Howe on "Some Floral and Scenic Features of Porto Rico." This was a semi-popular account of some of the more striking features of the native and introduced flora of the island and was illustrated by about a hundred lantern slides, some of which showed, incidentally, many interesting topographic and scenic details of the Porto Rican mountains and sea-coast. Special attention was given to the native palms and their economic uses. The photographs shown included, also, several of the cacti, which are much in evidence in certain places along the southern shore of Porto Rico and on the adjacent island of Culebra. In striking contrast with the xerophytic vegetation of the southern slopes are the mesophytic forests, now, unhappily, of very limited extent, on two or three of the highest mountains. The soil of the island is or has been very nearly all under cultivation, but in addition to the two or three comparatively small forested areas there are, here and there, in various parts of the island, rocky hills where the native vegetation may be found under very nearly natural conditions. The sugar, coffee and tobacco industries were also discussed and illustrated by the speaker.

Percy Wilson,
Secretary

SCIENCE

FRIDAY, JANUARY 14, 1910

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE PAST AND FUTURE OF THE STUDY OF SOLUTIONS[1]

SOLUTIONS have been known since earliest times, and the problems which they represent have been studied by a long line of very able investigators. All of the early work on solutions has been inseparably linked with the study of chemical phenomena. Indeed, up to the year 1887 chemical views of solutions have predominated. So for example, in his lectures delivered at Yale College in 1837, Benjamin Silliman, Sr., considered solutions as chemical compounds; and in his memorable work on theoretical chemistry which appeared in 1863, Herman Kopp treated solutions as chemical compounds that exhibit variable proportions, which mode of treatment was retained by A. Horstmann when in 1883 he wrote the second volume of the new edition of Kopp's work, now known as Graham-Otto's "Lehrbuch der physikalischen und theoretischen Chemie." Ever since the days of Lavoisier, when the so-called law of definite proportions was first recognized, a distinction has been drawn between compounds which follow that law and combinations that do not. Chemical combinations which exhibit definite qualitative and quantitative composition that can not be varied gradually by small increments arbitrarily chosen were soon termed definite chemical compounds, whereas solutions, whose composition may be varied gradually, quite arbitrarily—at least

[1] Address of the vice-president and chairman of Section C—Chemistry—American Association for the Advancement of Science, Boston, 1909.

within certain limits—were regarded as indefinite chemical compounds, or compounds according to variable proportions. So Robert Bunsen used to teach that we may have compounds according to definite proportions and also compounds according to variable proportions, the latter compounds being the group known as solutions.

The careful quantitative investigation of solutions really dates from the time of Lavoisier, who, as is well known, introduced the balance into the chemical laboratory. Before this the observations made were generally only qualitative in character; at any rate they were often crude and faulty. The very fact that solutions were regarded as chemical compounds led to their study by much the same methods adopted for the investigation of definite chemical compounds, *i. e.*, chemical compounds in the narrower sense in which the term is at present commonly used. So the qualitative composition and the quantitative composition of solutions were carefully studied. The density, the color, the boiling point, the specific heat, the optical activity, the thermal accompaniment of the formation of solutions and of their reactions with other substances, as well as their other physical, chemical and physiological properties, were studied in much the same way that these various properties were determined for definite chemical compounds. And yet, the fact that the composition of solutions may be varied gradually and arbitrarily within certain limits and that this can not be done in the case of definite chemical compounds, has for nearly a whole century been considered to be the vital difference between a solution and a definite chemical compound, and this is quite proper.

To obtain a definite chemical compound in the pure state usually requires a considerable amount of work. The usual operations of purification as in vogue at present are crystallization, solution and precipitation, sublimation and distillation. By means of the so-called purification process a product is finally obtained whose composition does not change further, though the substance be subjected to further similar treatment. As F. Wald states it, a chemical compound is a phase whose composition remains constant though temperature, pressure and contact with other phases be varied within certain limits inside of which the substance in question is stable. In a sense then the so-called definite chemical compounds are really obtained in certain cases as the more resistant cleavage pieces resulting when the purification processes are applied. That the latter processes after all frequently represent rather violent treatment will probably not be gainsaid by any one.

The law of definite proportions was considered by Ostwald in his Faraday lecture, which in turn was discussed by others, among whom Benedicks voiced the sentiment that after all when closely scrutinized it becomes evident that there is an arbitrary element in judging as to when we really have a pure, definite compound before us, and that the matter of definite proportions is to some extent one of definition. As to the law of multiple proportions, this has been directly challenged by P. Duhem as a tenet that can neither be proved nor disproved, though I must frankly confess my inability to agree completely with him in his argument.

The year 1887 is noteworthy, for it brought both the van't Hoff theory of dilute solutions and the theory of electrolytic dissociation of Arrhenius. These theories really supplement each other, as is well known. They may well be called physical theories of solutions as distinct from the chemical views of solutions al-

ready mentioned. It is quite unnecessary to rehearse here the great activity that has resulted in the study of dilute solutions during the last two decades as a direct consequence of the theories of van't Hoff and Arrhenius. The pages of the history of chemistry that record this experimental work on dilute solutions will ever maintain their brilliant luster, for they reflect the enthusiastic efforts of scores of active young hands and minds that were urged on by a most inspiring leader, an able teacher and experimenter, and a most lovable man —Wilhelm Ostwald. Without him the theories of van't Hoff and Arrhenius would scarcely have gained a foothold.

But excellent as were many of the experimental acquisitions that were thus obtained as a result of these working hypotheses, time has shown that the latter have long since served their purpose, and that mere physical conceptions of solutions are untenable as an explanation of the phenomena actually observed. Furthermore, a theory which applies merely to very dilute solutions, and then only in an imperfect way, is quite untenable in the long run, even as a working hypothesis. It is not my purpose to enter upon a discussion of the numerous experimental researches which have made the theories of van't Hoff and Arrhenius untenable. These investigations have been published at various times during the last decade, and I have dwelt upon them in detail on previous occasions. It is quite safe to assume that they are sufficiently well known to all. Moreover, I frankly confess that I am glad to escape the task of recounting again the weaknesses of these views of solutions as exhibited by experimental facts, for in my younger days I was quite enthused with these hypotheses, and it was to me a great disappointment to find later that they were contradicted by so many experimental truths. It is rather my purpose to point out the direction in which experimental investigations made thus far have led us, and to attempt to indicate the line of attack which must be followed to insure success in the future, so far as this can at present be foreseen.

The data collected since 1887 in studying the various properties of solutions, though frequently gathered with the aid of the physical hypotheses already named, have nevertheless gradually and unerringly demonstrated that the chemical view of solutions is far nearer to the truth, than is the idea that a solution is a mere physical mixture. In this connection permit me to call attention to a few experimental illustrations.

When antimony trichloride and camphor are brought together the two solids liquefy each other, forming a thick syrupy solution, the proportions of the two ingredients of which may be varied within certain limits. Antimony trichloride and chloral hydrate similarly liquefy each other, though less readily. Again, camphor and chloral hydrate when in intimate contact with each other form a liquid. If now cane sugar or paraffine be treated with antimony trichloride or with camphor or chloral hydrate no change will be observed. The question arises, why do antimony trichloride and camphor liquefy each other and cane sugar and camphor not? It is perfectly clear that all that we can say is that this is because of the specific nature of the substances themselves. In other words, antimony trichloride and camphor liquefy each other and sugar and camphor do not for reasons that are similar to those which we give as to why charcoal will burn and platinum will not. We may say that the mutual attraction, *i. e.,* the affinity of antimony trichloride for camphor, is sufficient to overcome their cohesions, and so they unite and form the solution. Now as to whether the antimony trichloride dis-

solves the camphor or the camphor the antimony trichloride is clearly an idle question. We may regard either the one or the other as the solvent, for this is obviously a purely arbitrary matter. Let us now raise the following question: In the syrupy liquid that has been formed by the action of antimony trichloride and camphor on each other, how much of the camphor present is combined with the antimony trichloride that has been employed? The answer is perfectly obvious, for clearly all of the antimony trichloride is combined with all of the camphor in the syrupy liquid that has been formed. One might as well ask the question: When mercury and oxygen unite to form mercuric oxide, how much of the oxygen present is united with the mercury that the oxide contains? Clearly here too all of the oxygen is united with all of the mercury present. When the solution of antimony trichloride and camphor is heated, the vapor obtained contains both of the ingredients. Similarly when we heat mercuric oxide the vapor contains mercury and oxygen. We see thus that the cases are essentially similar in character, the only difference being that in the case of the solution in question we have a compound according to variable proportions, whereas in the mercuric oxide we have a compound according to definite proportions.

Now when ice acts on sodium chloride is not the case quite similar to that of camphor and antimony trichloride? Suppose we knew of no temperature above 0° C., would any one argue that the solid ice dissolved the solid salt in the process of forming the brine? Certainly not, we should say that the brine has been formed by the union of the ice with the salt. And here similarly the question as to how much of the salt in the brine is united with how much of the water in the latter is quite idle, for obviously all of the salt used has united with all of the ice. The case would clearly not be altered if we started with liquid water and solid salt and formed the brine by the interaction of the two substances. This view, that in a solution all of the substances present are united with one another just as all of the elements in a definite compound are combined with one another, is to my mind the only rational view we can take of the matter. It is not new; on the contrary, it is quite old. It has been held quite generally by scientists prior to 1887, when the physical theories came upon the stage and diverted attention into other channels, as already stated, with the result that the true nature of solutions has been thoroughly obscured. If now we dilute the brine with more water, does the water added combine further with the salt present? Most assuredly, for is not the vapor tension of a brine, however dilute, lower than that of pure water, and does not this show that the water in the brine experiences greater difficulty in evaporating because of the mutual attraction between the salt and the water? Were any of the latter uncombined with the salt of the brine, this uncombined water would show the same vapor tension as pure water; but a brine of the same vapor tension as pure water of the same temperature does not exist.

The phase rule of Willard Gibbs marks a great advance in the study of heterogeneous equilibrium. Through the practical work of Bancroft, Roozeboom and numerous other able chemists, the phase rule has borne rich fruits. In all of this work the composition of the phases that are in equilibrium with one another under given conditions of temperature and pressure was carefully determined. This work has revolutionized solubility determinations, placing them upon an accurate scientific footing. Nowadays when the solubility of a compound is to be thor-

oughly investigated nothing less than the complete equilibrium curves of the compounds in question will suffice; but once the work is carefully done, it is final for all time. This is not the place to dwell upon all the various questions that have been cleared up by the application of the phase rule. It should here be emphasized, however, that the latter deals with the equilibrium of the various phases whose qualitative and quantitative composition is of course ascertained. As to the inner structure of any one of the phases the phase rule is able to tell us nothing. Indeed, in the study of single-phase chemistry, the phase rule is no help whatever. We may consider the investigation of the constitution of definite chemical compounds a part of single-phase chemistry, and we may similarly consider the question as to the inner nature of a solution (*i. e.*, of a compound according to variable proportions) as a problem of single-phase chemistry. In the investigation of the constitution of single phases it is quite impossible to get along without hypotheses. While the phase rule does not involve even the atomic and molecular theories, these are at present indispensable tools in prying into the inner nature of any one phase. But in the study of solutions, interest centers not so much in the equilibrium between phases as in the inner structure of the latter themselves.

Our methods of ascertaining the structure of chemical compounds are quite numerous, but they readily fall into a few categories. So we argue as to the structure of a compound from its synthesis, from its analysis, from its behavior toward various other chemical agents, from alteration by the application of pressure, heat, electricity, light and kindred agencies, and also from its various physical and physiological properties. Thus, for example, it has always been considered as sound reasoning that because red precipitate can be formed from mercury and oxygen, these substances are in red precipitate, which conclusion is verified by the fact that the latter compound may be decomposed into oxygen and mercury. There has never been any objection to the argument that if one of the elements actually enters into a compound during the latter's formation, or can be obtained from the compound either in the free state or in combination with other elements, that element is actually in the compound. So since calcium carbonate may be made from calcium, carbon and oxygen, we argue that these elements and these only are contained in calcium carbonate. Again, when calcium carbonate is heated, calcium oxide and carbon dioxide, and these only, are obtained; and conversely calcium carbonate may be formed by the union of calcium oxide and carbon dioxide. These facts were duly expressed by the old dualistic formula for calcium carbonate $CaO.CO_2$ which consequently had much to commend it. Yet while we thus hold that the elements calcium, carbon and oxygen are in calcium carbonate, we do not argue that this compound contains calcium oxide and carbon dioxide, even though the last two substances will unite and thus form calcium carbonate, or though they may be obtained as decomposition products of the latter compound. We write our formula for calcium carbonate $CaCO_3$ because of the precipitation methods by which the compound may be prepared, and because of the formulæ that we assign to soluble carbonates on the basis of the products that they yield by electrolysis. We consequently hold that the carbon dioxide and lime that form when calcium carbonate is heated result from the rearrangement of the atoms and splitting of the compound on account

of the violence to which it has been subjected by heating it very highly. Similarly, while we recognize that carbon, hydrogen and oxygen are contained in cane sugar, we do not argue that the latter consists of water and carbon, though these products may among others be obtained by heating sugar. Likewise we are loath to conclude that proteins contain amino acids, simply because these result as cleavage products when the proteins are subjected to certain rather drastic treatment.

Turning now, for example, to a compound like blue vitriol whose composition we are wont to express by the formula $CuSO_4.5H_2O$, to indicate that it consists of copper sulphate plus water, we find that the water may be driven off by heat properly applied and that the dehydrated copper sulphate remains behind. On heating the copper sulphate further it is decomposed into copper oxide and sulphur trioxide. If it were intended to express these changes by means of a formula, surely the old dualistic formula $CuO.SO_3.5H_2O$ would best indicate what has been observed. But here again we have departed from the idea that copper sulphate contains copper oxide and sulphur trioxide because upon electrolysis of an aqueous solution of copper sulphate, metallic copper, sulphuric acid and oxygen are obtained; while upon adding zinc or iron to a copper sulphate solution metallic copper is thrown out, and the sulphate of the more basic metal results. So far as the water content of blue vitriol crystals is concerned, we only know its relative amount and that it can be driven off by heat, higher temperatures being required to secure complete dehydration, while relatively lower temperatures will suffice to remove a large portion of the water. As to how this so-called water of crystallization is held, whether it is united with the copper sulphate simply as water molecules adhering to the copper sulphate molecule, or whether, like the oxygen and hydrogen content of the cane-sugar molecules, the oxygen and hydrogen in blue vitriol are united with the sulphur and copper in some more complicated way, is an open question. So far as the facts known are concerned, they are expressed by the formula $CuSO_4.5H_2O$, just as at one time the formula $CaO.CO_2$ expressed what was known about calcium carbonate. To me it would seem very probable that the hydrogen and oxygen content in blue vitriol is not present as water molecules clinging to the copper sulphate molecule, but some subtle experimental method, as yet quite unknown, is required to elucidate this matter, and until such a method is found we shall continue to write our formula for blue vitriol as we are wont to do. It is perhaps well in this connection to allude to the well-known fact that many salts containing water of crystallization can not be dehydrated by heating them, for when this is attempted not only water, but other ingredients as well, are driven off, in other words further deep-seated decomposition occurs.

If crystals of blue vitriol be placed in water, a blue liquid is formed as a result of the action of the crystals and water on each other. This liquid we call a solution. The amount of water and blue vitriol used in its preparation may be varied arbitrarily within certain limits. For reasons already stated, this blue liquid contains no water that is not in combination with the salt present, and also no salt that is uncombined with the water. The fact is that this blue liquid is found to be perfectly homogeneous by all tests that we are able to apply. If we add more water to it, this additional water also combines with all of the salt present and the liquid is again

homogeneous; and this dilution may be carried on indefinitely. If, on the other hand, we permit the blue liquid to evaporate, we thus decompose it by abstracting water from it. We say that the solution is becoming more concentrated. This change is a perfectly reversible one, and like all chemical changes it follows the law of mass action. The abstraction of water from a solution of copper sulphate by means of heat is just as truly an act of decomposing that liquid as is the abstraction of carbon dioxide from limestone when the latter is heated.

Blue vitriol is formed by the addition of water to anhydrous copper sulphate. The compound thus produced is quite stable at room temperature. If now we add anhydrous copper sulphate to crystals of blue vitriol, the latter lose part of their water content, which is taken up by the anhydrous salt till equilibrium is established. If, on the other hand, we treat the blue vitriol crystals with water, it is clear that we can not thus dehydrate the crystals. On the contrary, this added water will, because of mass action, tend to increase the stability of the complex which we represent by the formula $CuSO_4.5H_2O$, and to this complex all of the additional water present in the solution adds itself. What then is the formula of the hydrate contained in an aqueous copper sulphate solution at known temperature? This question is really an idle one, for since all of the copper sulphate present is combined with all of the water of the solution, the composition of the hydrate is clearly expressed by $CuSO_4.xH_2O$, where x represents the number of water molecules which the entire solution contains per each copper sulphate molecule; and so x increases as we dilute the solution and diminishes as we concentrate it. But this must not be taken as meaning that all of the water in a copper sulphate solution is equally strongly bound to the salt molecules. Indeed, in the case under consideration it is extremely probable that at least five molecules of water are more strongly bound to each copper sulphate molecule in the solution, for as the salt separates out, these five molecules remain in combination as a part of the compound. But while in the solution the copper sulphate molecule plus five molecules of water may be present as a nucleus to which the additional water molecules are attached, the force of attraction with which the outlying water molecules are held by the nucleus shades off so gradually as the radius of the sphere of influence increases that there is at no point any very sharp demarcation, and so it would be folly to attempt to ascribe any definite formula whatever to the hydrate existing in the solution. Attempts to deduce the formulæ of hydrates in solutions from the boiling points or freezing points of the latter are very far from the mark, though to be sure boiling-point and freezing-point curves do frequently show maxima and minima which are doubtless due to changes of intensity with which the water and salt molecules are held together as their relative number is changed. Furthermore, it is very significant that such maxima and minima in the boiling-point and freezing-point curves are found in the case of those substances, which, when they crystallize from the solution, do so with one or more molecules of the solvent attached as so-called crystal water. It is well known that at higher temperatures salts separate from solutions with less crystal water than at lower temperatures. Indeed at high temperatures the anhydrous salt is frequently in equilibrium with the saturated solution. So while at ordinary temperatures copper sulphate forms crystals with five molecules of water, at lower

temperatures it may be obtained with seven molecules of crystal water. Now would it then be right to conclude from this that at room temperature the hydrate in the solution is $CuSO_4.5H_2O$ and at lower temperatures $CuSO_4.7H_2O$? Obviously not, but we may say that it is at least that indicated by the composition of the compound that separates. In the solution itself many additional water molecules are combined with the salt molecules, and the force of attraction gradually shades off as the radius of the sphere of attraction from the nucleus outward increases so that it is quite impossible to ascribe any definite formula to the hydrate in the solution. (I should like to add parenthetically here that the recent attempts made to draw conclusions as to how many water molecules are attached to a portion of certain salts, from observations of changes of concentration that occur at the electrodes during electrolysis, are also based upon misapprehensions, but these details can not be taken up here.) It is, moreover, well known that when any physical property of a solution is studied at different temperatures the curve representing the alteration of that property with change of temperature does not show sharp points of inflection, indicating that whatever the internal alterations may be within the solution, they occur gradually rather than suddenly.

In the study of the various physical properties of solutions with changing temperature and changing concentration, it has been absolutely demonstrated that different solutions behave quite differently, and that solutions of compounds that are chemically analogous show an analogous, but by no means an identical, behavior. It is consequently quite impossible to write an equation that will hold for the various known solutions—not even approximately. Attempts to formulate an equation for a so-called perfect or ideal solution are about as successful as an attempt to write an equation for an ideal or perfect chemical compound would be. In short, such equations are necessarily based upon postulates that are not in accord with experimental facts, and consequently the equations themselves can not and do not agree with what is actually observed. The attempts to parallel solutions with gases in a quantitative way would naturally suggest that there might be an equation for an ideal or perfect solution just as we are wont to write an equation for a so-called ideal gas, but the suggestion is quite misleading, just as all of the efforts at a quantitative study of solutions based upon gas analogies have proved futile. This is true not only of solutions of moderate concentration, but of dilute solutions as well, as a careful unbiased scrutiny of the numerous experimental data that have been collected shows.

The act of solution is accompanied by all of the phenomena that are observed in the case of changes that are regarded as chemical by common consent, and this shows that solutions are chemical in character. We commonly say that whenever substances combine chemically with each other, the new substance formed has properties that are quite different from those possessed by the original substances. While this is true it is also the case that some of the properties are not changed at all, while others are but slightly modified, and still others are very greatly altered indeed. So, for instance, the weight remains unchanged during chemical action; the specific heat is frequently altered but little, whereas the color, volume and other properties may be very greatly affected. In general, we may say that *when an element or compound enters into combination with other elements or compounds, each of the ingredi*

ents of the new substance formed tends to retain its original characteristics as far as the new conditions to which it has been subjected permit. In reality every chemist is well aware of this, though as far as I know the idea has never before been stated in so many words. The degree to which an element loses its original properties on entering into combination with other elements depends very largely upon whether the chemical change involved is a drastic or a mild one, which in turn is principally determined by the energy accompaniments of the reaction. In the study of solutions, which in general represent rather compounds formed by relatively mild changes as compared with many of the stereotyped chemical reactions, the thought just expressed is particularly helpful. So, for instance, sodium has a great affinity for the elements of water, upon which the solubility of sodium compounds in water largely depends. On the other hand, sodium is inert toward hydrocarbons, which fact is at the basis of the insolubility of sodium salts in hydrocarbons. An element with pronounced chemical characteristics like sodium, for example, will retain to a high degree its chemical predilections even after it has entered into combination with other elements. Thus if we take sodium oleate, in which the metal is combined with the large fatty oleic radical, we nevertheless find that this soap dissolves in water. Here again the great affinity of sodium for water manifests itself, and though the metal is chained to the fatty radical which of itself exhibits no inclination to unite with water, yet this radical is dragged along into solution as it were by the great chemical attraction which sodium still has for water. But the combination which water and sodium oleate form is after all but a loose one, as one would naturally expect from what has been stated. The fact that a solution of sodium oleate boils but slightly higher than pure water shows that there is but little affinity between water and the soap. Again, the insolubility of sodium oleate in hydrocarbons shows that the oleic radical, though it is known to have affinity for hydrocarbons and fats, is yet unable to drag the sodium with it into solution. On the other hand, however, the affinity of the oleic radical for fatty substances does manifest itself when a strong aqueous soap solution is brought into contact with greasy matter on clothes, etc., for by virtue of this affinity the grease is loosened from the fabrics, and though not dissolved, it is nevertheless emulsified so that it can be removed mechanically with the soap solution. Numerous other examples illustrating the principles stated might here be mentioned. I am at present engaged in the work of collecting these. Before the advent of the physical theories of solutions considerable work was done in ascertaining the chemical relationships that must exist between solvent and solute in order that solution may take place; but during the last two decades this work has been practically discontinued, which is particularly unfortunate. It clearly indicates, however, how our so-called modern conceptions of solutions, which have been pressed upon the scientific public by a species of propagandism that is, and it is to be hoped will remain, quite unrivaled in the history of chemistry, have really stood in the way of progress.

In some quarters the idea is still prevalent that electrolytes are essentially different from non-electrolytes in their chemical behavior. This is thoroughly fallacious, for *all chemical changes that occur in electrolytes can now be reproduced as to type and as to rapidity in the best of insulators. An electrolytic solution behaves*

like any other solution, except that it has the property of conducting electricity with concomitant chemical decomposition. There is no way known at present by which any one can foretell whether a given solution will conduct the current or not. The only way to find out is by actual trial with the electric current itself. There is also a misapprehension that only electrolytes will cause the coagulation of colloids. Such coagulation can be quite as well accomplished by non-electrolytes, so that here too there is no essential difference between electrolytes and non-electrolytes. Upon what electrolytic conduction really depends we are still quite ignorant, just as we do not know why a bar of silver conducts and a stick of sulphur insulates. But upon this matter I have already expressed myself more fully on other occasions.

Again it is necessary to call attention to the fact that there is really no essential difference between colloidal solutions and solutions of crystalline substances. I do not refer to those so-called colloidal solutions which from the very mode of their preparation must be regarded as suspensions, which view has also been confirmed by the use of the ultramicroscope. *We are now able to separate crystalline bodies from each other by dialysis, also crystalline bodies from those that have never been obtained in the crystalline state by having the latter pass through the septum and the crystalloids remain behind; and indeed, even two colloids may be separated from each other by dialysis,* as I have demonstrated experimentally in the course of my researches on osmosis. The matter depends entirely upon the nature of the solutions and the chemical nature of the septum, and from a knowledge of these, what will happen may be foretold.

Water is a great solvent, and because of its abundance and importance to all life on the globe aqueous solutions will ever be studied with the greatest interest. But in obtaining a correct conception of the nature of solutions, aqueous solutions obviously can have no stronger vote than solutions in less abundant and far less readily procurable liquids. Water has a high cohesion, as is shown by its high surface tension and high latent heat of vaporization. The hydroxyl group which is characteristic of the water molecule certainly exhibits great tendency to cling to other hydroxyl groups. So, for instance, though hydrocarbons are not soluble in water, they become soluble when one of their hydrogen atoms is replaced by hydroxyl, provided that the number of carbon atoms in the compound is small. However, when more than one hydroxyl group is in an organic compound, the latter may have even a relatively high carbon content and yet be soluble in water. A study of organic hydroxyl derivatives shows that compounds consisting of carbon, hydrogen and oxygen, and containing one or more hydroxyl groups for every carbon atom present, are soluble in water, though, to be sure, even considerably less than one hydroxyl group per each atom of carbon in the molecule is frequently sufficient to cause solubility. On the other hand, the multiplication of hydroxyl groups in such compounds tends to diminish their solubility in hydrocarbons. From this and similar illustrations that might readily be given it is clear that a study of the solubility of a compound in different solvents may well serve as a means to investigate the nature of that compound.

It need not be feared that by accepting the chemical view of solutions we should lose the advantage of the molecular weight determinations by the boiling-point and freezing-point methods. These methods would serve us as well as ever. But we should not argue that common salt is dis-

sociated in water because a gram molecule of it added to a liter of water produces a solution that has a higher boiling point than the solution obtained by adding a gram molecule of sugar to a liter of water. We should rather hold that the higher boiling point of the former solution is due to the greater affinity between salt and water as compared with that between sugar and water.

The study of solutions then was begun with the chemical conception of solutions, and upon this conception many relationships have been worked out during the first eighty-seven years of the nineteenth century. The older chemists clearly recognized that whether solution will take place or not in a given case is first of all determined by the chemical nature of the substances brought into contact with each other. They saw that the temperature factor was next in importance, and that pressure was of vital consequence when a gas was under consideration, but of slight importance in the case of solids and liquids. When the conception that solutions are mere physical mixtures came to the foreground, through the introduction of gas analogies and the intense propagandism of the dilute school, the fact that the act of solution is really chemical in character was lost sight of by many able, enthusiastic young investigators. In the ardor of their quest they were misled, and unwittingly they naturally misled others. It is really pitiable to see how our physiologists, having thus taken up these misconceptions of the nature of solutions, are still wasting precious time in endeavoring to work out the complicated and very important processes that occur in living plants and animals. In these problems, which are in reality perhaps the very greatest that confront us at the present day, theories of solutions based on gas analogies are of no avail. They are thoroughly misleading and worse than worthless here.

The clear recognition that solutions are really chemical in character and that there is no wide gulf that separates the act of solution from other chemical phenomena, will do much toward furthering the future study of the subject. I do not claim to have prophetic ability, but nevertheless I venture to express it as my conviction, based upon years of experimental study of the chemical, physical and physiological properties of a long list of both aqueous and non-aqueous solutions, that the act of solution is chemical, that solutions are chemical combinations, and that we can only make real progress toward a better understanding of the various solutions by recognizing this as the basis of all of our future work. The efforts to gain a better insight into the different solutions that confront us must be chiefly experimental, rather than mathematical; for in the study of solutions, just as in the study of chemical compounds in the narrower sense of the word, we are continually confronted with discontinuities. Now discontinuous functions can not be handled mathematically at present, not even by the greatest of our mathematicians, for though work of this kind has been begun, it is still in a very rudimentary stage. It is highly probable too that the renewed study of solutions from the chemical point of view will greatly aid us in getting a broader and more correct conception of the nature of chemical action itself. Certainly in living beings we have numerous, fundamental and deep-seated chemical changes going on continually with apparently the greatest ease at ordinary temperatures and pressures, and it is tantalizing that we are unable to comprehend how this is all brought about. In the unraveling of the

questions that here confront us a clear recognition that solutions are chemical in nature will be of greatest service.

LOUIS KAHLENBERG

ON THE NATURE OF RESPONSE TO CHEMICAL STIMULATION[1]

IN its last analysis we may readily enough suppose that the response of organisms to any stimulus is indirectly, at least, a result of chemical stimulation. That is to say, we may suppose that any change of environmental or internal conditions, whether it be of a chemical nature or of what is ordinarily called a strictly physical nature, awakens response by reason of chemical changes which are induced by its action, and these chemical changes are themselves the starting point for the chain of reactions which eventually evince themselves as the response.

A factor like increase of temperature very likely depends for its effect considerably, if not very largely, upon the chemical readjustments which it causes within the protoplasm. We have of course in the first place what might be called the primary or unmodified effect of increased temperature—the general acceleration of chemical processes which under such conditions is axiomatic in both inorganic and organic reactions and which does not necessarily imply any change in the chemical constitution of the protoplasm. But we should not assume too readily that the case is as simple as this, for organisms do not respond in the manner in which they would were their protoplasm a stable compound. In short, we are justified in supposing that certain changes of a more or less profound nature, due to altered chemical constitution, are the net result of rise in temperature. For instance, a change of temperature will increase the intracellular activity of the protoplasm and may readily disturb the balance of the metabolic processes so that the production of a larger amount of excreted waste products will further accentuate or perhaps even modify the response by reason of a purely chemical stimulation caused by these very waste substances. Again, it is well known that one of the critical points of protoplasm as regards temperature—the coagulation point—depends upon the amount of water held by the protoplasm, including without doubt chemical as well as physical constitution of water. The less water, the higher the coagulation point, or in other words, the less water the less readily the final chemical reaction of protoplasm to heat takes place. The longer the organism is subjected to new conditions of temperature the more permanent the changes become, as is shown by the phenomena of acclimatization; and the more gradual these changes are, the less likely are they to result in the destruction of the plant.

In the response of protoplasm to light we have another instance where an external physical factor affects the chemical structure within the organism and thereby sets up reactions which are traceable to chemical stimuli. Without referring to the action of the red-orange rays in photosynthesis, I may call your attention in this regard to the action of light as a whole as a formative stimulus in tissue differentiation. In the absence of light, as is now well known, the production of the more elaborate prosenchymatic tissues is, to a large extent, if not wholly, inhibited. Now we can not suppose that light rays alone are directly responsible for, let us say, the lignification of the mechanical tissue in a stem, but their action is to cause certain chemical changes which constitute the stimulus which enables the living tissue to

[1] Address of the vice-president and chairman of Section G—Botany. American Association for the Advancement of Science, Boston, 1909.

build up this particular form of cell wall. It is interesting too to note in this connection that certain poisons of a purely chemical nature have the same effect in retarding tissue differentiation as does the absence of light. This would seem to indicate that this particular phase, at least, of the response was due to a form of auto-intoxication of the normally illuminated tissues when grown in the absence of light.

It is, however, not necessary to dwell further on this aspect of the question. Few, if any, physiologists would to-day be inclined to deny the ultimate chemical nature of the response of protoplasm to any form of stimulus. It is the purpose here to limit the examination of chemical irritation more especially to actual concrete chemical substances brought into relation with living protoplasm, and to inquire somewhat more particularly into their mode of action and the nature of the changes which they induce. The importance and fundamental nature of these reactions can not be doubted.

For this purpose we may include in the list all those substances which it may reasonably be believed induce, by their chemical action, constitutional changes in protoplasm. These substances may be mineral salts, organic compounds of great diversity of structure, including anesthetics which have been perhaps wrongly placed in a special class, and even gases of a simple constitution. They may be crystalloidal, electrolytes or non-electrolytes, or perhaps even colloidal.

As a starting point it is necessary to admit that there are certain chemical elements which must be supplied to the plant for what is considered its normal development. Ordinarily these elements are supplied to the autotrophic plant in the form of oxygen, carbon dioxide, water and solutions of certain mineral salts, with the substitution in the case of heterotrophic forms of some suitable organic compound of carbon. For all of these necessary simple substances there is supposedly an optimum tonic point of concentration, though experience shows that it may vary somewhat, and the same is true of the more complex organic food supplied to the plant devoid of chlorophyll.

Moreover, not only must these substances be presented in an acceptable form and in the proper concentration, but there must also be a proper physiological balance in the mixture of the raw foodstuffs. The relation of the plant to the so-called normal food supply is not the question which it is here specifically our purpose to discuss, and we may assume that the plant is supplied, under the most favorable conditions, with sources of raw food material and is under the influence of favorable external conditions.

However, there are some points in regard to the normal food supply which have a direct bearing upon the question of chemical stimulation, as defined even in its restricted sense, which should be referred to before passing on to the main subject. In the case of some of the necessary food materials the concentration may vary within relatively wide limits before the effects of a lack or excess of these substances are observable. In such cases the increase necessary to produce a reaction may readily be so great as to involve a material increment in the isotonic coefficient of the solution and thus confuse any result produced by any direct chemical stimulus with those initiated by the change in osmotic pressure. Potassium salts, for example, will fail to elicit any response in the growth of fungi until the concentration is so increased as to raise the osmotic pressure by several atmospheres. It is known, however, that some of the necessary salts which are required by the plant in relatively

small quantities may, if the concentration be raised above the normal point, cause a secondary stimulation of growth and eventually, if the increase be continued, become inhibitory after the manner of poisons. Iron salts accelerate the growth of certain fungi far above the normal, when present in even slight excess, although the increase in concentration is nowhere nearly sufficient to raise measurably the osmotic coefficient of the solution. It has likewise been shown that under certain conditions calcium and magnesium salts seem to stimulate growth in a manner which may be considered strictly chemical, although with some plants the added concentration makes necessary a consideration of possible osmotic changes. It should also be said that in the case of the relation of calcium and magnesium the question of physiological balance between the two appears to be especially important, though this of course would not apply to fungi where magnesium alone is required. The question of the rôle of the elements which are needed in only very small quantities, especially in the case of iron, is a highly interesting one and it is strongly suggested that they are in their normal relation to the protoplasm of the nature of chemical stimulants rather than of necessary food elements. Calcium would not indeed come under this head if, as some believe, certain calceo-proteids are essential constituents of the living substance, but for iron and to a lesser extent magnesium and perhaps even potassium a purely chemical relation is highly likely. Iron salts at least may simulate the action of a catalytic agent, a point of view which will be more fully explained later.

In any event, in speaking of necessary raw food material, the question must be regarded as a purely relative one, and one should not cling too closely to the conventional idea of what a plant must be provided with. A multitude of special cases show that the relation of protoplasm to the so-called necessary elements may be very different in different cases. Anaerobic bacteria, for instance, are exceedingly sensitive to free oxygen, the presence of infinitesimal quantities of which in the case of certain Spirilla acts as a stimulus to induce a vigorous negative tactic response. Again, among the nitrifying bacteria forms are known where the presence of sugar, usually so acceptable to non-chlorophyllous plants, acts unfavorably. Instances of this sort might be multiplied, but it is the purpose at this time simply to call attention to the fact that chemical stimulation and eventually even toxic action may result from the presence of substances ordinarily regarded as necessary to sustain life.

It is indeed the case, then, that any substance whose presence may influence the behavior of a plant either normally or abnormally is of the nature of a chemical stimulus and therefore belongs to the topic under discussion. Since, however, our knowledge along these lines is very scanty and since we can from ocular evidence recognize what may be fairly termed a normal growth in a plant, I prefer to assume for the time, as has already been stated, that a plant furnished with the necessary food materials to produce its typical morphological development and with these substances in optimum concentration, is in a state of equilibrium as far as chemical stimulation in its restricted sense is concerned.

In this connection attention may be called to what appears to be an error in the point of departure of some investigators who have endeavored to determine the relative stimulatory value of certain substances, whether these be necessary or not to the plant. The mistake comes in the reference to distilled water as the medium

in which control cultures are grown, the variant being the same distilled water plus the substance under investigation. It is obvious that metabolic processes and consequently growth can take place only in such plants or plant parts in which elaborated food material is stored. It is equally obvious that the osmotic relations must be disturbed. Besides the lack of chemical balance there is also a lack of physiological balance. Plants under experimentation to determine the effect of chemical stimulation should be referred for comparison to those grown under conditions which are as nearly as may be the ones which can be recognized as producing opportunity for what experience shows is the natural morphological development of the organism. The physiologist should no more neglect the morphological aspects of his investigations than should the morphologist the physiological.

In its restricted sense, then, chemical stimulation may be said to deal with the effects of chemical agents which are not only not necessary, but which may be positively deleterious to the organism—poisons in short. It has been established that many, if not all, classes of substances which exert a toxic action on protoplasm will become stimulatory if presented to the cells in sufficiently small doses. Somewhere between an infinitesimally weak solution which produces no reaction, to the toxic dose which kills there is a stimulative optimum which gives the maximum of reaction. Experience shows that this is true of widely different substances—a poisonous gas like carbon monoxide, a poisonous metallic salt like copper sulphate, a simple organic compound like chloroform or a more complex one like an alkaloid, all come under this head. The question which concerns this paper is not the possible ultimate lethal effect of these poisons, but how far they may serve to excite the protoplasm to extraordinary activity. The amount required to effect the latter result will naturally vary with the substance, certain mild poisons possibly never affecting the plant beyond the stage of stimulating growth, no matter how high a concentration was employed.

From the work of Raulin and others, it is known that metallic salts in themselves toxic to protoplasm will, if presented to it in minimal doses, accelerate vegetative processes in a variety of plant forms. Certain fungi may be made to develop their vegetative hyphæ much more luxuriantly by the addition to their nutrient substratum of quantities as small as .0005 normal of zinc sulphate, and the increase of dry weight of cell substance produced may exceed by 200 per cent. or more that which is formed by similar cultures without stimulation. Nor is this limited to salts of the heavy metals, nor indeed to inorganic substances, for organic substances such as glucosides and alkaloids, or even simpler ones like chloroform, produce a similar if not so marked result.

In the concentration necessary to produce the characteristic reactions there is great diversity. As would be expected, not only are different substances very unequally stimulatory or toxic, but also the same substance varies greatly in the amount required to stimulate different organisms. Copper sulphate, one of the most violent of poisons to plant protoplasm, does not inhibit the growth of *Penicillium* until a concentration of nine per cent. is reached, yet the effect of the same salt is so enormously poisonous to many algæ that an infinitesimally weak solution will speedily cause death. What is true of the toxic point is true also of the stimulatory optimum. In the attempt to explain such disparities stress has been laid by some on

the probable impermeability of the cell membranes to this highly toxic salt in the case of the resistant forms. I am inclined to believe myself, however, that it is probably not so much due to such causes as to specific differences in the constitution of the protoplasm itself, which renders the usually poisonous substances relatively inoperative. There hardly seems enough evidence to support the idea of any very highly specialized qualitative selective power on the part of the cell membranes in the matter of dissociable and diffusible salts. On the other hand, there are many reasons for looking upon protoplasm not as a uniform substance, but as differing considerably in different plants. The fact that some plants can not thrive except in the complete absence of oxygen is enough to illustrate this point. The condition of the stimulated plant may itself cause a variation in the optimum concentration of the stimulant, as is shown by the effect of rise in temperature on the lowering of the toxic or stimulatory dose. It is not only among lowly organized plants like fungi that stimulation follows such conditions, but among the higher vascular plants as well. We can not suppose that these stimulants react directly upon the protoplasm or themselves supply the energy necessary for the changes which they induce with a possible reservation in the cases of those salts whose valency may be subject to change. In the first place, they fall in very different groups of toxic substances, if we take Loew's well-known classification, and yet there is a great similarity in the reaction produced. Therefore it is reasonable, for the time being, to disregard to a considerable extent the question of the chemical nature of the stimulating substance as far as its effects in accelerating the life processes of the organism are concerned. This does not mean, however, that the ultimate effect on the manner in which these poisonous substances may, in strong solutions, kill the protoplasm is not related to the chemical nature of the toxic agent. Not only are the stimulants not the sources of energy for the changes involved, but also they can not, in most cases at least, be regarded in themselves as catalyzers, no matter how greatly the end result of their action might suggest their being of such a nature. If, therefore, we are to find any satisfactory clue to the answer to the question of the influence of these minute doses, we must look rather towards the indirect effect they may exert and endeavor to discover if they may not encourage the formation by the protoplasm itself of substances which do act in a catalytic fashion. It seems clear, then, that the poisonous action of a given substance may be, and probably commonly is, very different from the stimulating effect of small doses of the same substance.

Whether it is safe to say that all substances which are toxic must of necessity act as stimulants if presented in sufficiently dilute form is a question. It is conceivable that some might produce no reaction unless present in a lethal dose, but it seems probable that most substances will show a stimulating reaction at the proper dilution. In this connection it is well to remember that we should not confuse the necessarily more complicated reaction of higher animal forms, whose balance of function is so delicate and whose tissue structures are so very diverse, with the more fundamental and presumably simpler and more direct reactions of the less interdependent cell aggregations such as are found in plants. It is reasonable to suppose, however, that as far as the cells themselves are concerned the underlying principles are much the same in all organisms.

Upon inquiring more closely into the effects of stimulants, we find that while a

great deal is unknown there are a number of important facts concerning which there is positive information and which throw considerable light on what is really taking place under such conditions. It is best, before taking up the physiological reactions, to consider the morphological changes which ensue, which, if we wish to employ modern terminology, we may term "chemomorphosis." The information regarding the lower forms—particularly the fungi—is the fullest and will be considered first.

The primal fact of the increase on dry weight has already been spoken of and is the simplest of all the reactions to demonstrate. By the easy process of the desiccation and weighing of a series of cultures the stimulation curve of the whole range of possible concentrations from minimum to maximum may be determined. Although it must be said that to obtain definite results means which might seem to some to be exaggeratedly careful must be taken to ensure the purity of all substances entering into the culture medium. Not only is the quantity of mycelium formed greater, but also the form and appearance are very different. Fungi commonly cease to form conidia under stimulation, the mycelial felts are buckled and knotted instead of being flat and even and their consistency is different, being tough and leathery instead of somewhat tenuous in texture as in the normal growth. In short they present every appearance of more luxuriant vegetative activity. The cell forms are often different, especially among bacteria, where the so-called involution forms arise apparently from chemical stimulation. Among many of the fungi, at least, such conditions are tantamount to a state of hyperplasia, if we may use the term in speaking of such lowly organized forms. Among the higher plants there may be simply an increased rate of growth and an ultimately greater stature, or, in other cases, as in the local application of metallic salts in initiating local intumescences or in hastening and increasing the formation of wound tissue, actual hypertrophies may be induced. In the stimulation afforded by parasitic fungi or by gall insects the great expression of abnormal growth is to be seen amounting often to relatively large outgrowths of tissue. The reaction in these various cases would seem to differ rather in degree than in kind, and it is perhaps a question not in this case of a mere hastening of growth, but of the excitation being sufficiently violent to destroy the equilibrium of growth which exists among the cells.

In no such case, however, have we any evidence that the variations in form so induced are inheritable. It is only when the germ cells at or near the time of their formation are directly stimulated that we get any changes in the offspring which are passed on to the succeeding generations. Sometime, it may be, means will be found by which an excitation of the sporophyte can be made in some way to influence the gametophytic cells and thus induce permanent variations through influences brought to bear indirectly upon the gametophyte, though it is not to be supposed even in that case that the particular response induced in the original sporophyte will be repeated in its offspring.

It is evident, from the effect of parasitic fungi upon their hosts, that not only does the stimulus of the parasitism of a specific fungus produce more or less specific results, but also that the condition of the parasitized cells themselves influence the result. The more primitive or meristematic are the cells the greater the resultant effect in the way of a distortion, for, as is well known, the greatest hypertrophies take place when the infection is in the

growing points of the shoots and becomes less and less when the more stable and permanent tissues like leaf parenchyma are attacked. The same fungus which causes real hyperplasia in young tissue produces but a hypertrophic enlargement in the adult parenchyma.

Such being the case, one might be warranted in reasoning by analogy that the still more plastic cells of the gametophyte would be even more profoundly influenced by stimulation and such indeed appears from MacDougal's experiments to be the case. It is also not unreasonable to suppose that the inciting cause of the healing of wounds, of stimulus to growth after injury, and even of regeneration phenomena themselves, harks back to a question of chemical stimulation. In the more massive tissues, at any rate, wounding results in the exposure of interior cells directly to the action of the oxygen of the air, and is accompanied by increased metabolic activity. The more rapid growth of injured parts, the awakening of dormant buds, may well be influenced or initiated, though probably not eventually controlled, by chemical stimulation arising from this or similar causes.

It is not to be supposed in any case that the chemical substances in question themselves constitute—by any direct union with the protoplasm—the modifications which ensue. It is only possible here to touch thus briefly upon the morphological responses induced by chemical stimulation, for the field is an enormous one. In some of its aspects, the study of the immediate effect of environment upon the external and internal form of a plant comes under this head. There is without question a large and inviting field for investigations into the nature of the changes in structure which are correlated with chemical stimulation.

It is necessary also to pass over without further comment the directive effects of chemical stimulation upon growth and movement, concerning which there are many investigations as to the expression of the reaction, but very little information as to the intimate causes of it.

After this brief consideration of the changes in the actual amount of elaborated substance, of stature and of structure which commonly attend chemical stimulus and which are the outward signs of its workings, we may next turn to the more fundamental question of what we know of the influence of this excitation on the physiological activities of the plant.

One fact which is clearly marked in the case of certain fungi that have been investigated is that the protoplasm, when stimulated, works more economically in respect to the carbohydrate food material supplied than when unstimulated. The latter produces a larger crop, as estimated from the dry weight, from a given amount of sugar than the normal culture does: there is less waste. Were the metabolic activity of protoplasm to be interpreted simply in terms of economy of action, one might be tempted to speak of such a condition as more nearly approximating a perfect or so-called normal; but when we reflect that we know so little of the chemical action and interaction of living protoplasm, it would be unwarranted to assume that mere economy of consumption of one form of food material would tell the whole story. The plant is attuned to an average condition and its attunement to that condition constitutes the nearest approach to what we may call normal. The increased availability of the sugar under chemical stimulation may be regarded as an untoward, fortuitous condition which, while it may be optimal for the processes involved in building up vegetative hyphæ, is not optimal for the development of the

plant as a whole, as is evidenced by the suspension of spore formation. This increased availability of the carbohydrate food is, then, distinctly unusual as far as the ordinary life processes of the fungus are concerned. The cessation of conidial spore formation which characterizes even slight stimulation is a morphological abnormality in the usual life cycle of the mostly asexual hyphomycetous fungi, and while it might be argued that spore formation is an evidence in itself of at least the initiation of unfavorable conditions, such considerations hardly apply here. It would be true only in a very limited degree, for the stimulus to spore formation need not necessarily be inimical in any large sense of the word. Whether it is the more economical working of the protoplasm which inhibits the formation of conidia or whether the absence of the latter results in less waste of energy in metabolism is perhaps a question, though probably most would agree that the spore-forming process is one that demands a greater expenditure of energy than the mere vegetative growth of the hyphæ.

From what we know of the effect of chemical stimulants upon the eggs of organisms, it would look as though the processes set up by such excitation are more critical for the sexual cells than for those of what may be regarded as the sporophyte. It would be exceedingly valuable to discover more about the relation of chemical stimulation to the production of gametes or their equivalents, and here we have another attractive field that has not been largely cultivated. It may be said in passing that as far as these non-sexual hyphomycetous forms are concerned there is not much evidence to show that such chemical stimulation as has been tried is sufficient to restore the ability, in many cases long lost, to produce sexual fruit.

It has been stated that there is less waste as well as a greater economy in manufacture of dry substance. One would naturally suppose that the two go hand in hand, but it is well to specify more definitely in what this smaller waste consists. One of the characteristic products, though not indeed necessarily an end product of katabolic activity in the plant cell, is oxalic acid, particularly in the case of these same fungi which we have been considering, where it is freely excreted into the substratum. Now the amount of this may be determined with relative ease, and it has been shown that with a stimulated crop there is a marked decrease in the ratio of the oxalic acid formed to the amount of dry substance produced in a given time. Together with this the carbon dioxide production does not appear to much more than parallel the increase in the weight; or in other words, the formation of this gas is approximately normal. This being the case, it at once becomes evident that the carbohydrate represented by the difference of oxalic-acid production in the normal and in the stimulated plants is at the disposal of the organism in the constructive processes. As for the higher plants, it has been shown that an increase in carbon-dioxide production takes place under stimulation, but these results are hardly complete, having been made without reference to net gain in substance. This matter should be further investigated, since it appears that the formation of wound tissue, when subjected to stimulation, is accompanied on the average by a greatly lessened carbon-dioxide production as compared with unstimulated growth; and this, too, in spite of the fact that there is ocular evidence that greater cell activity results under conditions of stimulation.

A highly interesting and instructive light on this question is thrown by the be-

havior of *Sterigmatocystis nigra* in relation to its assimilation of nitrogenous material. This fungus has the power, to a limited extent at least, of assimilating free nitrogen from the air. Stimulation appears to diminish this ability and to cause the fungus to rely more largely upon the nitrate fed to it: or at any rate the organism does not excrete into the liquid substratum as large an amount of waste nitrogenous products as does the normal. Furthermore, the nitrogenous content of the dry substance of the plant is not affected one way or the other. In regard to the nitrogen supplied in combined form, there is less thrift in the stimulated than in the normal growth, but, on the other hand, the total amount of nitrogen involved, including that excreted as waste into the substratum, is less in the former than in the latter case. This whole question is, of course, a hugely complicated one and in the light of our relatively slight knowledge of nitrogen metabolism one which should be approached with caution. But it is evident that the problem is of great importance.

In this connection it is apropos to quote from practically the only investigation we have which touches on this point.

To explain the reason for the activity of the organism along these lines there are these suggestions: one that the fixation of free nitrogen and its excretion in combined form may be a function connected with fructification, since stimulated felts do not produce spores; another . . . is that the stimulated crop, driven to its most rapid metabolic activity by the stimulant, is forced to consume its carbohydrate more economically and therefore finds less energy to use in effecting the combination of the relatively inert and difficultly combinable nitrogen, and so must use the more readily assimilable compound nitrogen; or again it may be that since by the presence of the stimulant the fungus can consume carbohydrate more thoroughly and with less waste, therefore it finds in what would be a normal amount under ordinary circumstances a more than necessary amount under the favoring influence of the stimulant, which, of course, would be then potentially a too great supply, and the result would be over feeding in this direction and therefore there would be a tendency to lessened activity in expending energy for nitrogen combination. This last hypothesis is in accord with conclusions that have been reached on the activity of the root tubercle bacteria in fixing nitrogen when well supplied with nitrogen compounds, but not in accord with the results of those who find that the fixation of nitrogen is directly proportional to the amount of sugar at hand.

After consideration of the whole matter, one is inclined to the opinion that, after all, since less nitrogen passes through the fungus for the amount of dry substance formed, there is economy in nitrogen as well as in carbohydrate metabolism in a stimulated growth. And taking it all in all, there seems to be sufficient evidence for maintaining that under chemical excitation of optimum intensity the waste involved in mere cell formation, at least, is not so great in stimulated as in unstimulated protoplasm.

In this connection there arises at once another question of great importance, namely, what influence stimulation has on enzymatic activity. While the data on this point are still incomplete, it is permissible here to make reference to certain results not yet completed which throw some light upon this phase of the matter. Here again *Sterigmatocystis nigra* is valuable for experimentation. In common with many of its kind, this fungus can live on a great variety of substrata, its ability to do so being due in large measure to its versatility in the excreting of an enzyme appropriate to the particular compound on which it is growing. Thus it will produce maltase when grown on maltose, sucrase when grown on saccharose, inulase on inulin, amylase on starch, etc. A quantitative estimation of its hydrolyzing power

would afford some clue to the enzymatic activity of the stimulated fungus as compared with the normal growth, and experiments seem to show pretty clearly that there is greater proportional enzymatic activity in the former than in the latter. The same point is even more clearly illustrated by the various researches on the influence of chemical irritation upon alcoholic fermentation by yeasts. A variety of substances in minimal doses have been found to increase the fermentative activity of these fungi. While in such cases we are, of course, dealing with extracellular enzymes, it is not unreasonable to suppose that by analogy similar excitation follows with the intracellular enzymes. The intracellular enzymes are the ones which we may legitimately suppose to be connected more or less directly with the metabolic activity of the living organism. Now if anabolic activity is connected in any way with the reversible action of enzymes—as seems likely—we have here another link in the chain of evidence as to the real nature of chemical stimulation. We may hope in time to reduce it entirely to a question of enzyme formation. In order to do so we must devise more precise means for investigating the intracellular enzymes in the plants experimented upon and to determine if there is any quantitative difference as a result of stimulation. If it can be proved that this causes a relative increase in synthesizing enzymes in the fungus hyphæ a long step toward a more complete understanding of the processes will have been made. It should be acknowledged that at present such considerations are in a measure purely speculative, yet not speculative to the extent of being other than founded on the meager knowledge at hand. There is nothing improbable in such conclusions. The synthetic action of enzymes is a question which is more and more attracting the attention of the investigator, and while the results along these lines are comparatively new and relatively few in number, they are sufficiently conclusive to permit of a broad application of the principle involved. I will cite only one instance, and that in relation to an extracellular enzyme, where isomaltose has been synthesized from glucose by the action of maltase and, further, where the same enzyme was utilized in the synthesis of the glucoside amygdalin. Granting then that we may have in enzymes active agents in the constructive work of the organism, it is possible to understand how an increase in enzymatic activity could explain many of the phenomena connected with the response to chemical irritation.

There still remains, of course, the most fundamental question why and in what manner the specific irritants used affect the quantitative and even perhaps the qualitative formation of enzymes, and here there is no ready or sufficient answer to give. At first glance it does not appear to be connected with their dissociation in weak solutions, for non-electrolytes like morphine give a reaction as well as dissociable salts, although it is to be remarked that the concentration required with the former is many times greater than with the latter. If, as is believed by some, the *poisonous* action of salts depends on the degree of their dissociation, it is probably equally true that the stimulative action of minimal doses of these same salts is influenced by this same factor. But this assumption does not dispose of the large class of non-electrolytic poisons (and consequently stimulants), although I venture to suggest that the introduction of such substances into the sphere of protoplasmic activity may result in the formation by the protoplasm of by-products which are dissociable poisonous substances. Such an explanation would help to account for the large doses

of non-electrolytes which are necessary to produce a reaction on the plant organism.

There seems to be a much greater universality in the manner of the response to stimulation by poisons than in their actual toxic effect, a fact that has already been noticed, and for that reason I am strongly inclined to the opinion that the former does not depend upon the particular form which the latter may take, and so the increased enzymatic action may be considered to be a general phenomenon connected with this class of response.

There at once suggest themselves many very interesting problems in regard to the relation of chemical stimulation to morbid hypertrophies—using the word in its broadest sense—in higher plants, and also to what might be called the normal hypertrophies which ensue in the tissues of the ovary wall and surrounding parts after fertilization, without touching on the great question of the development of the fertilized egg itself.

In a previous address before this section, attention was called to the possible enzymatic changes induced by untoward chemical stimulation of the germ cells of certain plants and the results of this stimulation on the offspring. In the light of my own acquaintance with the question of chemical stimulation I see nothing improbable in such a point of view, even though we can not prove it at present.

There are many other considerations in connection with the question which might be profitably discussed and I am aware that I have really touched upon one side of the problem only, practically neglecting the morphogenic influence of chemical stimulants, but sufficient time has already been consumed and to open up new topics would be but to strain your patience further. The point which I have endeavored to develop and which I here repeat is that the chemical stimulants which have been discussed produce their effect indirectly and the nature of the response appears to be one of the increase of constructive enzymatic action over that which would take place under normal conditions from an equal and similar food supply.

H. M. Richards

Barnard College,
Columbia University

PUBLIC LECTURES AT THE HARVARD MEDICAL SCHOOL

The faculty of medicine of Harvard University offers a course of free public lectures, to be given at the Medical School, Longwood Avenue, Boston, Saturday evenings at 8, and Sunday afternoons at 4, beginning January 2, and ending April 30, 1910. Doors will be closed at five minutes past the hour. No tickets are required. Following is a list of the lectures and their subjects, with dates:

January 2—"The Influence of Mental and Muscular Work on Nutritive Processes" (illustrated), by Dr. F. P. Benedict.

January 8—"The Story of Vaccination," by Dr. M. J. Rosenau.

January 9—"What the Public should know about Patent Medicines," by Dr. M. V. Tyrode.

January 15—"Clean Milk" (illustrated), by Dr. Calvin G. Page.

January 16—"The Growth of School Children and its Relation to Disease," by Dr. W. T. Porter.

January 22—"Sprains, Strains and Fractures: Simple Facts of Diagnosis and Treatment" (illustrated), by Dr. J. B. Blake.

January 23—"The Glands of Internal Secretion and their Relations to Health and Disease" (illustrated), by Dr. W. B. Cannon.

January 29—"Small-pox" (illustrated), by Dr. J. H. McCollom.

January 30—"Hearing and Speech," by Dr. C. J. Blake.

February 5—"Posture and Carriage as affected by School and Clothing," by Dr. R. W. Lovett.

February 6—"The Care of Infants with Special Reference to the Prevention of Disease," by Dr. Maynard Ladd.

February 12—"Voice Production," by Dr. J. Payson Clark.

February 13—"Nervous Diseases in Children," by Dr. W. N. Bullard.

February 19—"Uses of the Microscope," by Dr. H. C. Ernst.

February 20—"Laboratory Methods, with the Microscope and Otherwise," by Dr. J. L. Bremer.

February 26—"What the Public may Rightfully expect from the Dentist," by Dr. C. A. Brackett.

February 27—"How Tumors Look under the Microscope" (illustrated), by Dr. F. B. Mallory.

March 5—"Foot Discomfort: its Cause and Rational Treatment," by Dr. R. B. Osgood.

March 6—"The Care of the Skin in Health and Disease," by Dr. C. J. White.

March 12—"The Treatment of Surgical Tuberculosis," by Dr. E. H. Bradford.

March 13—"The Abdominal Emergencies and the Need of Early Recognition and Prompt Remedy," by Dr. M. H. Richardson.

March 19—"The Hygiene of Early Life," by Dr. T. M. Rotch.

March 20—"The Dietetics of Early Life," by Dr. C. H. Dunn.

March 26—"Poliomyelitis Anterior Acuta," by Dr. J. L. Morse.

March 27—"The Diagnosis of Acute Febrile Disease," by Dr. Henry Jackson.

April 2—"The Value and Uses of the X-ray," by Dr. Percy Brown.

April 3—"How to Gain or Lose Weight," by Dr. F. W. White.

April 9—"The Way and How of Breathing," by Dr. E. G. Martin.

April 10—"Personal Hygiene" (to women only), by Dr. C. M. Green.

April 16—"The Nature and Proportion of Cures in Insanity," by Dr. E. E. Southard.

April 17—"Insanity and Modern Civilization," by Dr. F. H. Packard.

April 23—"Medical Advertisements and Kindred Subjects" (to men only), by Dr. Abner Post.

April 24—"On the Etiology of Certain Diseases Peculiar to the Tropics," by Dr. E. E. Tyzzer.

April 30—"The Healthy Man and his Bacteria," by Dr. A. M. Worthington.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING

AT the meeting of the trustees of the foundation, held on November 17, the rules for the granting of retiring allowances were amended so as to recognize service as an instructor in the retirement on the basis of age or disability, and the right to retirement for professors under sixty-five years of age with a minimum of service of twenty-five years was restricted to cases of disability. The retiring allowances of widows of professors who have served twenty-five years are retained.

The amended rules read as follows:

RULE I

Any person sixty-five years of age who has had not less than fifteen years of service as a professor, or not less than twenty-five years of service as instructor[1] or as instructor and professor, and who is at the time a professor or an instructor in an accepted institution, shall be entitled to an annual retiring allowance computed as follows:

(*a*) For an active pay of twelve hundred dollars or less, an allowance of one thousand dollars, provided no retiring allowance shall exceed ninety per cent. of the active pay.

(*b*) For an active pay greater than twelve hundred dollars the retiring allowance shall equal one thousand dollars, increased by fifty dollars for each one hundred dollars of active pay in excess of twelve hundred dollars.

(*c*) No retiring allowance shall exceed four thousand dollars.

Computed by the formula: $R = A/2 + 400$, where R = annual retiring allowance and A = active pay.

RULE II

Any person who has had twenty-five years of service as a professor or thirty years of service as professor and instructor, and who is at the time either a professor or an instructor in an accepted institution, shall, in the case of disability unfitting him for the work of a teacher as shown by medical examination, be entitled to a retiring allowance computed as follows:

[1] An instructor is held to be a college or university teacher to whom is assigned independent teaching or the conduct of laboratory work or of classes under the direction or supervision of a professor or head of a department. The term is not intended to include demonstrators, mechanicians, laboratory helpers or other assistants who are not charged with the responsibility for the conduct of college classes, nor is it held to include those who give any considerable part of their time to gainful occupations other than college teaching. The foundation reserves the right to decide in all doubtful cases what constitutes service as an instructor.

(a) For an active pay of twelve hundred dollars or less, a retiring allowance of eight hundred dollars, provided that no retiring allowance shall exceed eighty per cent. of the active pay.

(b) For an active pay greater than twelve hundred dollars, the retiring allowance shall equal eight hundred dollars, increased by forty dollars for each one hundred dollars in excess of twelve hundred dollars.

(c) For each additional year of service above twenty-five for a professor, or above thirty for an instructor, the retiring allowance shall be increased by one per cent. of the active pay.

(d) No retiring allowance shall exceed four thousand dollars.

Computed by the formula: $R = A/100(b + 15) + 320$, where R = retiring allowance, A = active pay and b = number of years of service.

RULE III

A widow who has been for ten years the wife of a teacher, who at the time of his death was in receipt of a retiring allowance, or who at the time of his death was eligible to a retiring allowance, or who had had twenty-five years of service as a professor or thirty years of service as an instructor and professor, shall receive as a pension one half of the retiring allowance to which her husband was entitled under rule I. or would have been entitled under rule II. in case of disability.

RULE IV

In the preceding rules, years of leave of absence are to be counted as years of service, but not exceeding one year in seven. Librarians, registrars, recorders and administrative officers of long tenure whose salaries may be classed with those of professors and assistant professors, are considered eligible to the benefits of a retiring allowance.

RULE V

Teachers in the professional departments of universities whose principal work is outside the profession of teaching are not included.

RULE VI

The benefits of the foundation shall not be available to those whose active service ceased before April 16, 1905, the date of Mr. Carnegie's original letter to the trustees.

RULE VII

In counting years of service toward a retiring allowance it is not necessary that the entire service shall have been given in institutions upon the accepted list of the foundation, but only years of service in an institution of higher education will be accepted as an equivalent.

RULE VIII

In no case shall any allowance be paid to a teacher who continues to give the whole or a part of his time to the work of teaching as a member of the instructing staff of any institution.

RULE IX

The Carnegie Foundation for the Advancement of Teaching retains the power to alter these rules in such manner as experience may indicate as desirable for the benefit of the whole body of teachers.

SCIENTIFIC NOTES AND NEWS

READERS of SCIENCE will have learned with regret of the circumstances leading to the retirement of Mr. Gifford Pinchot from the direction of the Forest Service.

DR. C. F. CHANDLER, since 1864 professor of chemistry in Columbia University, will retire from active service at the close of the present academic year. The trustees have passed a resolution expressing their high appreciation of his services to the university.

PROFESSOR THEODORE W. RICHARDS, of Harvard University, has been reappointed research associate of the Carnegie Institution of Washington, having received a new grant of $2,500 for the continuation of his researches on atomic weights and other physico-chemical constants.

PROFESSOR G. P. BAXTER has also been reappointed a research associate of the institution and a grant of $1,000 has been made to him for the continuation of investigations upon atomic weights.

PROFESSOR E. J. WILCZYNSKI, of the University of Illinois, has been awarded a prize of eight hundred franks by the Royal Academy of Science, Letters and Fine Arts of Belgium, for his memoir on "The General Theory of Congruences." This prize was announced some time ago by the academy for the most noteworthy development of some phase of the application of differential geometry to ruled space.

DR. F. W. PUTNAM, emeritus professor of American archeology and ethnology at Harvard University, has been appointed honorary academician of the Museum of the National University of La Plata in the section of the natural sciences.

PROFESSOR KARL RUNGE, of the University of Göttingen, Kaiser Wilhelm professor at Columbia University, and Professor Otto Jespersen, visiting professor from the University of Copenhagen, have been given the degrees of D.Sc. and D.Litt., respectively, by Columbia University.

IN recognition of the services rendered by him in the reform of medical education in Hungary, and of the active interest taken by him in the International Medical Congress held last year at Budapest, the medical faculty of the university of that city has conferred on Count Albert Apponyi, the minister of education, the honorary degree of doctor of medicine.

MR. JOHN A. VOGELSON has been appointed chief of the Philadelphia Bureau of Health in succession to Dr. A. C. Abbott, who resigned some months ago.

MR. C. H. T. TOWNSEND has been given leave of absence by the Department of Agriculture for eighteen months to inaugurate an entomological service for the Peruvian government.

THE American Nature-study Society has elected Professor O. W. Caldwell, of the University of Chicago, president of the society, and Professor F. L. Charles, of the University of Illinois, secretary and editor of *The Nature-study Review*. The office of that journal will be removed from New York City to Urbana, Ill.

DR. AUSTIN M. PATTERSON was elected editor and M. John J. Miller associate editor, of *Chemical Abstracts* at the Boston meeting of the American Chemical Society, Professor W. A. Noyes, of the University of Illinois retiring. The office of this publication was removed last August from Illinois to Ohio State University, where it has since been in charge of Dr. Patterson as associate editor.

DR. WILLIS L. MOORE, chief of the Weather Bureau, delivered a lecture on December 27 in the assembly room of the Automobile Club of America, New York City, on "The Work of the Weather Bureau in Relation to Aeronautics."

DR. E. L. THORNDIKE, professor of educational psychology in Teachers College, Columbia University, gave on January 11 an address before the Middletown Scientific Association on "Experimental Studies in Animal Intelligence."

SIR ERNEST SHACKLETON lectured in Rome on his Antarctic expedition on January 3. Among those present were the king and queen.

DR. G. BOWDLER SHARPE, assistant keeper in the department of zoology of the British Natural History Museum, and eminent as an ornithologist, died on December 25, at the age of sixty-two years.

PROFESSOR H. H. GIGLIONE, director of the Royal Museum of Natural History and professor of zoology at Florence, known as an ethnologist as well as a zoologist, died on December 20, at the age of sixty-six years.

DR. EDOUARD BRISSAUD, professor in the Paris School of Medicine and well known for his work in pathological anatomy and medicine, has died at the age of fifty-two years.

A BILL has been introduced into the house of representatives making the present Bureau of Education a Department of Education with a secretary in the Cabinet.

THE offices of the Bureau of American Ethnology were on January 1, 1910, transferred from the Adams Building on F Street to quarters in the Smithsonian building. Mr. F. W. Hodge on that date assumed charge of the bureau with the title of ethnologist-in-charge.

THE path of Halley's comet has been added to the planetarium in the Foyer of the American Museum of Natural History, and its position in the solar system will be indicated daily during the next few months, while the comet is visible to the unaided eye.

THE New York Aquarium had a greater number of visitors during the year 1909 than

ever before, the attendance being 3,803,501, an average of 10,417 a day. These figures show that the aquarium has a greater patronage by the public than all the other museums of the city, including the Zoological Park, combined. These figures are unequalled by those of any other museum in the world of which statistics are available.

THE Geological Survey's report on the production of copper in 1908, prepared by B. S. Butler, is now ready for distribution. The mine production, smelter output and refinery production in 1908 exceeded those of 1907. The production in 1908 by smelters from copper-bearing material mined in the United States was 942,570,721 pounds, the largest in the history of the industry. The production in 1906, the next largest, was 917,805,682 pounds; that for 1907 was 868,996,491 pounds. The world's production of copper in 1908 was 1,667,098,000 pounds, so that the United States contributed considerably more than half the total product of the metal. The exports of refined copper were 618,613,842 pounds, the largest amount recorded; the imports were 218,705,487 pounds, mostly from Mexico, Canada and Peru. The domestic consumption of new copper in 1908 was 480,000,000 pounds; of old copper 23,000,000 pounds, making the total domestic consumption 503,000,000 pounds, against 547,000,000 pounds in 1907. The stock on hand January 1, 1908, was 125,745,796 pounds; on January 1, 1909, it was 121,876,759 pounds. The average quoted price of electrolytic copper at New York in 1908 was 13.2 cents a pound. In 1907 the price was 20 cents a pound. The commercial conditions during the year were very stable, the variations in monthly average price covering a range of only 1.54 cents, as compared with 11.90 cents in 1907. A notable feature of the industry was a decrease in cost of production due to improvements in methods and the increased efficiency of labor. Arizona ranks first in the production of copper, Montana, Michigan, Utah, California, Tennessee, Colorado, Nevada, Idaho and New Mexico following in the order named. According to the smelter returns the three leading copper states—Arizona, Montana and Michigan—produced 81 per cent. of the total output in 1908.

THE London *Times* states that the exhibition which is to open in December next at Allahabad will be the largest ever held in India. While essentially non-official in character, the strong executive committee in charge enjoys the support of the local government, which is itself managing the agricultural, forest and educational courts. Sir John Hewett, the present lieutenant-governor, who was lately commercial member in the governor-general's council, and other government officials are giving their aid in every legitimate way. The exhibition committee specially desire machinery and demonstrating processes for the agricultural, engineering and textile courts. As is stated in the preliminary prospectus, "the main object of the exhibition is to encourage the arts and industries of the united provinces by displaying products and methods of production and by introducing from other countries such commodities as are required to supplement indigenous productions." The first aviation meeting in the east will be held in connection with the exhibition.

IN the course of its last session the state legislature of North Dakota provided for the establishment of a biological station on the shore of Devils Lake. The bill places the station under the direction and control of the trustees of the University of North Dakota, and provides that the biological staff of the university shall direct the work of the station. The bill further states that, "It shall be the duty of the staff of said station, as directors thereof, to study the animals and plants in Devils Lake and other portions of North Dakota with reference to the problem of restocking and cultivating fish in Devils Lake and in any other waters of the state, especially those of an alkaline character, such as Devils Lake; to study and make collections of any animals and plants in North Dakota that have commercial and scientific value." The station is housed in a commodious, artistic building of cobble and concrete. The equipment, now being procured, will consist of boats, dredges, seines, pumps and all the

varied apparatus necessary for the study of small animals and plant forms. The laboratories will be equipped, some of them for general students of biology and some for special research. Salt water from the lake and fresh water from other sources will provide for the aquaria and other receptacles. Investigations already made show that Devils Lake swarms with life in great numbers though not in great variety of species. North Dakota has a rare opportunity to study the biological stages of variation, adaptation and isolation, and it is the purpose of this new station to provide for biological students and to offer facilities for trained investigators who may desire to carry on research under such conditions as exist in that region.

THE *Auk* states that the Museum of Comparative Zoology at Harvard University has received during the past year the most noteworthy accessions to its bird collection in its history. These include, as the most important, the E. A. and O. Bangs collection, containing approximately 24,000 skins, chiefly from North and middle America and the West Indies. Most of those from Central America were taken by Mr. Wilmot W. Brown and Mr. C. F. Underwood, well known as intelligent and energetic collectors, the former noted for his skill in preparing skins of birds and mammals. The specimens have been determined by Mr. Outram Bangs, with the assistance of Mr. Ridgway and Dr. Richmond. They also include the types of the many new forms described in recent years by Mr. Bangs. Another gift of unusual importance consists of several thousand specimens from the interior of central and western China, presented by Mr. John E. Thayer. A collection of over 3,000 skins collected in Palestine have been acquired by purchase. A considerable number of other skins and mounted specimens of unusual interest have also been acquired, by gift or purchase, from other sources.

UNIVERSITY AND EDUCATIONAL NEWS

THE late Arthur Hill, regent of the University of Michigan, has bequeathed $200,000 to the university for the erection of an auditorium.

THE gift of $650,000 by Mrs. Russell Sage to pay for the Hillhouse property, of Yale University, will release a considerable sum which, according to the correspondent in the N. Y. *Evening Post,* will probably be used for work in biology.

THE building of the University College of Medicine, at Richmond, Va., was destroyed by fire on January 6, entailing a loss estimated at $200,000.

THE board of trustees of the Massachusetts Agricultural College having received propositions from the Boston & Albany Railroad and also from electric railroads centering in Springfield to run agricultural educational trains over their respective lines, it has been voted, "That this board will heartily cooperate with these railroads, the Board of Agriculture, the Chamber of Commerce and other organizations in the state to further the development and success of this project. To this end it will tender the services of its teachers and experts and place at the disposal of these railroads such equipment and apparatus as may be required."

AT the annual meeting of the governors of the Nottingham University College on December 22 it was announced that it was the intention of the council to develop immediately a scheme for submission to the court of governors that application might be made for a full charter, so that Nottingham College would become a degree-conferring university.

DR. C. J. KEYSER has been appointed head of the department of mathematics of Columbia University, to succeed Professor J. H. Van Amringe, who retires from active service at the close of the academic year.

DR. J. L. SIMONSEN has resigned his position as assistant lecturer and demonstrator in chemistry in Manchester University to accept the chair of chemistry in the University of Madras. Mr. Alfred Holt, M.A., D.Sc., has been appointed as his successor.

Mr. L. A. Borradaile, M.A., of Selwyn College, has been appointed university lecturer in zoology at Cambridge University.

DISCUSSION AND CORRESPONDENCE

COTTON ANTHRACNOSE

Since Dr. Atkinson's work on cotton anthracnose, 1890–3, little has been done on this now important disease. Recent work here has brought out some very interesting points which in a way confirm some of Dr. Atkinson's theories in connection with the infection of seed and seedlings. Last winter while working with seed taken from a field where the disease occurred the previous summer, I found anthracnose occurring in a number of germination tests. This led me to search for the fungus in the tissue of the seed. I found that by taking bolls which were slightly diseased and mature it was an easy matter to find the fungus filaments beneath the seed coats and in the tissues of the cotyledons. The spores of the fungus are also readily found between the seed coats and the cotyledons of mature seed. Numerous inoculation experiments during the past summer show that the fungus seems to prefer the seed and lint to other portions of the plant. In fact, in some cases the attack is confined to these parts, there being no sign of the disease on the walls of the bolls. In some cases where the bolls mature and the cotton opens out with no sign of disease other than slight discoloration of the lint, the fungus will be found on such lint and in the seed. Such seed, of course, when planted produce diseased seedlings and thus spread the disease. This season numerous outbreaks of anthracnose in various sections of this state have been traced to diseased seed. Some of these occurred where cotton had never been planted before. From an economic standpoint this phase of the problem seems to be very important. The south is now sustaining a loss of millions of dollars annually from anthracnose. It has been estimated that the state of Georgia loses over $14,000,000 annually and a very conservative estimate of the loss of South Carolina would be from $400,000 to $500,000 annually.

Since the twentieth of last July I have been unable to isolate the fungus from the fields where cotton was planted last year. From this it seems that a one year's rotation with disease-free seed might eliminate the disease.

Interesting results have also been obtained in reference to seed treatment, method of infection of the bolls, resistance of different varieties of cotton, breeding resistant strains, etc., all of which will be published at an early date in report of the South Carolina Experiment Station.

H. W. Barre,
Botanist

South Carolina Experiment Station
October 26, 1909

METAPHYSICS AND MENDELISM

There are reasons for regarding man as a chimpanzee on which an additional element, "manness," has been superposed. There you have man expressed or explained in terms of his anthropoid ancestor. The characters of a frog are undoubtedly latent in the frog's tadpole. What is to hinder, therefore, expressing or explaining the frog in terms of the tadpole by saying the tadpole carries the characters of the frog? The logic is sound in the statement that the tadpole contains frog factors or "frogness." The question is merely as to the helpfulness of sound logic used that way.[1]

The helpfulness of sound logic, aside from its use as a mental discipline, is usually based on its relevance to the matter under discussion. As regards the chimpanzee we shall doubtless all agree with the learned Californian if he will advance scientific proof that in homo-simian hybrids "chimpanzeeness" and "manness" behave toward each other in Mendelian ratio; for it is Mendelian inheritance, it must be remembered, that the English scientists are talking about. If the tadpole contained the potentiality of developing either into a frog or, let us say, a salamander, according to circumstances under experimental control, we might consider "frogness" as a factor, the presence or absence of which would have a determinative influence in development.

[1] "The Hypothesis of 'Presence and Absence' in Mendelian Inheritance," W. E. Ritter, Science, September 17, 1909.

In other words, the allusions to the frog and chimpanzee, true or otherwise, are not particularly illuminating in a discussion of Mendelism because there is involved no feature of dominance nor alternation of characters.

In Mr. Punnett's original statement of what is known as the Cuénot theory:[3]

There are but two relations into which the unsplittable unit character can enter with the individual. It may be present or it may be absent and no third relation can be conceived. From this we are led to ask whether the hypothesis can be brought into any simple relation with the phenomenon of dominance. Is dominance the outcome of the presence of the given factor, and recessiveness the condition implied by its absence? At present we can only say that such a point of view is not at variance with the great majority of cases hitherto worked out. Whether the few instances which now seem contradictory will ultimately fall into line, future work alone can decide.

Nothing very cryptic or very dogmatic about that. In speaking of "roseness," "peaness," etc., Mr. Punnett has merely framed a convenient and probably temporary handle to grasp a difficult subject in order the better to inspect it. We owe him a vote of thanks, that, instead of christening his conceptions with newly coined words dug from the dusty depths of the Greek lexicon, he has rather chosen to emphasize their temporary character by Englishing them, lest others should read into his statements a concreteness he manifestly wishes to avoid.

The writer is of those who believe that the dangerous facility with which the facts of Mendelism fall into categories and A-B-C notations is illusory and that the matter is more complicated than those would have us think who have allowed themselves to be entangled in all-explaining formulæ. Yet working hypotheses we must have in order to advance, and none suggested so far is any more usable, certainly none more lucid, than the one Professor Ritter finds so contaminated with metaphysics.

J. F. ABBOTT

ST. LOUIS, MO.,
September 29, 1909

[3] R. C. Punnett, "Mendelism," 1907.

HYDROGEN POLYSULPHIDE AS A REDUCING AGENT

I SHOULD like to correct a clerical error in the account I gave a few months ago[1] of my investigation of the reducing action of hydrogen polysulphide. The statement "it may be used at the ordinary temperature, dissolved in ionizing solvents, such as water or alcohol, or in non-ionizing media, such as carbon bisulphide" should read "it may be used at the ordinary temperature, *for the reduction of substances* dissolved in, etc."

As is well known, the polysulphide is practically insoluble in water and alcohol.

ALFRED TINGLE

LABORATORY OF THE IMPERIAL CHINESE
PEI YANG MINT, TIENTSIN,
October 10, 1909

[1] SCIENCE, XXX., 158 (July 30, 1909).

SCIENTIFIC BOOKS

Landmarks of Botanical History. By EDWARD LEE GREENE. Smithsonian Miscellaneous Collections (Vol. 54), 1909.

We have had many histories of botany, each of which has added somewhat to our knowledge of the growth of the science and of the men who have been its chief workers, or they have given us a new point of view so that we have been able to see how botany has grown and developed from its crude beginnings to the present. In Dr. Greene's book we have another attempt to set forth the matter in a new light, and at the outset it may be said that few men could bring to the task better ability, training and preparation. Nor are there many men who can command equal library facilities, for Dr. Greene's unrivaled private library of the earlier botanical works is supplemented by the Congressional Library, to which as an attaché of the Smithsonian Institution he has had the freest access. This happy coincidence with the unusual freedom from official duties afforded by his position, and a persevering industry, have conspired to favor the production of a monumental work.

In choosing for his title the word "landmarks" the author indicated something as to

what his treatment of the problem was to be. He has chosen to bring before his readers the lives and teachings of botanists, and necessarily he must choose those who have contributed to the upbuilding of the science. This treatment is in sharp contrast with the chronological method in which each botanist is taken up in his proper place, and his various publications cited, much as they are in a publisher's descriptive book list. It is also quite different from the treatment made familiar to us by the well-known history of botany written by the late Professor Sachs, in which the development of each department of botany is traced consecutively and consistently. In the latter treatment the subject is so emphasized that the men themselves fall somewhat into the shadow; we think of how this or that part of the science developed, but largely overlook the personal element as represented by the men by whose labors the development took place. By the one method we have a work on botany in which the present condition of each part of the science is accurately given, and we are shown by what steps this condition was reached. In this treatment the botanists are but the workmen who have helped to build the edifice of science; they are important only as they have added stones to its structure, and while the historian mentions their names, these are wholly secondary, and may be forgotten in our admiration of the aggregate result of their work. By the other method we are brought to consider the workmen who have labored upon the edifice; how they worked; how they succeeded in their endeavors; how they failed here and there, and why they failed, as well as why they succeeded. By this treatment we learn not only what progress was made in the upbuilding of the science, but also *how* it was made. For the botanist who wishes merely to know the material of the edifice, the method of Sachs is preferred, but for the investigator who desires to know the conditions under which his predecessors did their work the other method is indispensable.

As indicated above, Dr. Greene has chosen to write his history so as to place the emphasis first upon the men who have worked in botany. It is thus a very human book, and as one reads the biographies of the men he has selected a vivid picture is presented of their lives and their labors, as well as their environment. As one reads he gets some idea of the atmosphere in which men lived, and he appreciates all the more the difficulties they encountered, and the meaning of success in their particular environment.

It is understood that this history—"Landmarks"— will cover several volumes, and certainly if one may judge of the succeeding volumes by the first there can be no question as to the desirability of continuing the work as it has been begun. It opens with a most readable and suggestive preface, in which the author gives his definition of botany—as that science "that occupies itself with the contemplation of plant as related to plant, and with the whole vegetable kingdom as viewed philosophically—not economically or commercially—in its relation to the mineral on the one hand, and to the animal on the other." It is, however, distinctly set forth that to the botanist all matters relating to plants must be of interest, and he has clearly no sympathy with those who would close their eyes to the industrial relations of the science. He goes so far, even, as to include as "essentially botanical" those philosophic ideas, though crude or erroneous, about the vegetable kingdom as a whole or in part which may occur to "the farmer, the woodsman and the primitive pharmacist" and others who have much to do with plants industrially. With this liberal interpretation no broadly trained botanist will find fault, nor should the workers in agriculture, forestry and other allied subjects object to this inclusion of the philosophical aspects of these phases of plant study.

The introduction, covering about thirty pages and devoted to The Philosophy of Botanical History, is well worth reading, since it is full of suggestions, some of which we should like to quote if there were space to do so. The root-gatherers ("Rhizotomi") "mostly illiterate men and quacks," who preceded Aristotle and Theophrastus, receive liberal treatment in a short chapter. This is followed (chapter

II.) by nearly a hundred pages devoted to Theophrastus of Eresos, one of the most instructive parts of the book. The treatment here illustrates the author's method, who says (p. 60): "In our study of this maker of the first Landmark in the History of Botany the main object must be that of discovering in what ways, under what limitations, and yet how well, he accomplished the placing knowledge of plant life and form upon the list of the sciences." Accordingly, a dozen pages are given to a discussion of his method, which is in fact continued through nearly thirty pages more under the subtitles Organography and Anthology. After this Phytography (5 pages) leads to Taxonomy (20 pages) and Dendrology (8 pages). The chapter closes with a recapitulation in which the author shows that Theophrastus "is the father of the Science as we now have and hold it."

The short chapter on the Greeks and Romans after Theophrastus (enumerating Nicander, Cato, Varro, Virgil, Columella, Dioscorides, Pliny and Galen) leads to a still shorter one on the botany of the middle ages, the author remarking in passing that "the period has no apparent landmarks of botanical history."

Otho Brunfels (chapter V.), who is characterized as "first in point of time among the German botanical reformers of the sixteenth century," leads the way to Leonhardus Fuchsius and Hieronymus Tragus, to each of whom a chapter is assigned. The short chapter (VIII.) devoted to Euricius Cordus leads naturally to the following (IX.) on Valerius Cordus, the son, "hitherto almost unknown except by name." This closing chapter of the volume will be read with keen interest by every botanist, who will learn here for the first time, perhaps, of this brilliant botanist whose death when but twenty-nine years of age closed a life of much achievement and still greater promise. To have rescued the name of Cordus and his work from oblivion was a worthy labor, and most zealously has Dr. Greene carried it out. He shows that Cordus formulated plans for his plant descriptions, and that with these he redescribed "some of the best known and best described plants of Dioscorides," which is characterized as "the boldest innovation that was made by any botanist of the whole sixteenth century."

The "Landmarks of Botanical History" will certainly be of the greatest value to botanists the world over, since it presents the subject in a new light and from a different point of view. We shall all pray for the continued health and strength of the author, and that opportunity may be afforded him of completing the work to which he has set his hand.

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

The Moon in Modern Astronomy. By PH. FAUTH. With an introduction by J. E. GORE, F.R.A.S Pp. 160 with 66 illustrations. New York, D. Van Nostrand Company. 1909.

This attractive book gives a very interesting account of the principal features visible on the moon's surface and it embodies the results of over twenty years of careful study with small telescopes. The subject is treated in an historical manner, especial attention being given to the early maps of Lohrmann, Mädler and Schmidt. M. Fauth shows that photographic processes have not materially added to our knowledge of lunar conditions. In fixing the relative positions of the larger surface features photographs are more accurate than maps made from eye observations, but for the study of minute detail visual observations, even if made with relatively small telescopes, are superior to the best photographs.

The most conspicuous features of the moon's surface are the so-called "craters." These have heretofore been described as "cup-shaped" mountains and as resembling but greatly exceeding the great volcanic craters of the earth. M. Fauth shows that this conception of the lunar "craters" is erroneous, that they are more like shallow dishes, and could more appropriately be called "walled-plains." He shows by figures and by diagrams that in many cases the crater is "so incredibly shallow that the eye of an observer on the crest would hardly be able to see the crest on

the opposite side, because the depression is so slight that the curvature of the moon's surface covers the opposite wall." Or again "A dessert dish five inches in diameter (without the border) and less than a quarter of an inch in depth has twice as deep a cavity, proportionally, as the deepest of these depressions."

M. Fauth considers in detail the various theories that have been advanced to account for the origin of these peculiar features of the lunar surface and rejects them all as unsatisfactory. Yet it can not be said that he has disproved the volcanic theory, although he has certainly pointed out many difficulties in the generally accepted idea of that theory. But the theory that he advances in its place, that the moon's surface is covered by a deep layer of ice, will not be accepted without convincing proof.

The book is well printed and illustrated and is well worth reading by those who take an interest in the moon.

C. L. P.

In Starland with a Three-inch Telescope. By WILLIAM TYLER OLCOTT. Pp. 146 with many diagrams. New York, G. P. Putnam's Sons. 1909.

This is a convenient hand-book or guide for the amateur astronomer. A three-inch telescope is too small to show any planetary detail and the owner of such an instrument is practically limited to the study of the moon and of a small number of the brighter double stars. To a description of these objects, therefore, the book is confined.

Only the constellations visible in the latitude of the New England and Middle States are included and these constellations are divided into four groups, corresponding to the seasons of the year in which they are visible. For each constellation a clear and simple page map is given and on this map are marked the positions of the interesting double stars. Facing each map is a printed page, which gives the necessary details for finding and observing these objects.

The moon is treated in a similar manner, eight diagrams of different phases being given. These show the principal features only and should be of great assistance to the student of lunar detail.

The book is well printed, the maps and diagrams well designed and executed, and the little volume is admirably adapted to encourage the study of the heavens.

C. L. P.

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Experimental Zoology, Vol. VII., No. 2, contains the following papers: "Wound Reparation and Polarity in Tentacles of Actinians," by Herbert W. Rand. A distal cut end of a tentacle of the large actinian, *Condylactis,* is immediately closed by muscular contraction and remains so during a slow process of structural repair which eventually replaces the muscular contraction. The distal cut end of an excised fragment of tentacle behaves similarly, but a proximal cut end does not close. In the conspicuously different behaviors of proximal and distal cut ends, and in responses to tactile stimulation, the tentacle shows a marked polarity which can not be accounted for upon the basis of its known structure. "A Biological and Cytological Study of Sex Determination in Phylloxerans and Aphids," by T. H. Morgan. An analysis of the behavior of the sex chromosomes in phylloxerans in connection with the behavior of the sex chromosomes in other hemiptera leads to the conclusion that these chromosomes can not be male and female determining as such, but that they are identical in all respects. Two alternative views offer themselves if this analysis is correct. Either sex is determined quantitatively by the amount of elimination contained in the fertilized egg—a view advanced by the author in 1907 and since adopted by Wilson and by Castle in a modified form—or else the presence or absence of the sex chromosomes are associated with other profound, invisible differences in the two classes of spermatozoa. It is difficult to decide at present between these alternatives, but the facts here recorded for the phylloxerans favor the interpretation that the visible chromosomal differences in the two

classes of spermatozoa are associated with more profound differences in the sperm and that it is these differences rather than the difference in quantity alone that have a determinative influence in sex determination. An examination of almost 10,000 male and female eggs of *P. caryæcaulis* shows that the male eggs occur about five times as often as the female eggs. A study of the output of each stem-mother shows that in some cases all of her progeny are males, in other cases all females, and in most cases both males and females with a preponderance of males. The results are obviously not connected with chance combinations of chromosomes, but definite "tendencies" exist in certain individuals that follow one or the other alternative. These tendencies might seem to be the result of external factors, but nothing was discovered in the history of the individuals that favors such an interpretation; although the possibility of such an effect must be granted. The author's general conclusion is summed up in the statement that the quantitative interpretation of sex-determination is only the first rude approximation to a solution. The facts suggest that the visible quantitative differences are associated with more profound changes and the facts described for the phylloxeran egg give some indication of the nature of those changes; for, the sex chromosomes seem rather to follow sex than to be its sole cause.

"Factors of Form Regulation in *Harenactis attenuata*, III., Regulation in Rings," by C. M. Child. Under certain conditions short cylindrical pieces from the body of the actinian, *Harenactis attenuata* form "rings" by the union of oral and aboral ends. Such rings may give rise to one or several more or less radially symmetrical groups of tentacles in the region of union.

THE FIRST CRUISE OF THE "CARNEGIE" AND HER EQUIPMENT[1]

THE *Carnegie*, engaged in a magnetic survey of the oceans under the direction of the department of terrestrial magnetism of the Carnegie Institution of Washington, entered on her first cruise August 21 last. As may be recalled, this is the first vessel in which the attempt has been made to exclude practically all materials affecting the compass needle. Hence the magnetic data secured on her can be made immediately available, it being now unnecessary to await the determination of troublesome and more or less uncertain deviation corrections.

The tests made at Gardiner's Bay, Long Island, August 21 to September 2, and at Falmouth, England, have demonstrated conclusively that no correction of whatever kind need be applied to the *Carnegie* results. The following table will show the close agreement in the values of the three magnetic elements obtained on the various headings during the swings at Gardiner's Bay:

Ship's Head	Magnetic Declination (Variation of the Compass)	Magnetic Dip.	Horizontal Magnetic Intensity (C.G.S. Units)
N.	11°25′ W.	72°01′	.1825
NE.	26	07	23
E.	28	07	25
SE.	22	07	25
S.	22	05	27
SW.	19	02	25
W.	21	05	22
NW.	27	11	23
Mean	11 24	72 06	.1825

Nothing could be more satisfactory than this exhibit of the fulfillment of the requirements as to non-magnetic conditions at the places where the instruments are mounted.

The observations made on the trip from New London, Conn., to St. Johns, Newfoundland, and from there to Falmouth, England, during the severe October gales afforded ample opportunity for trying out the observational appliances, and these stood the tests put upon them, during the exceptionally adverse conditions, even beyond expectations. A large part of the instrumental equipment was especially designed and constructed in the workshop of the Department of Terrestrial Magnetism.

In brief, it may be confidently asserted that

[1] Abstract of paper presented before the Philosophical Society of Washington, November 20, 1909, by Dr. L. A. Bauer, of the Carnegie Institution of Washington.

ocean magnetic work is now on a stage of perfection not hitherto reached, permitting obtaining useful data not only expeditiously but also with all necessary accuracy both as regards practical and scientific demands.

The introduction of circular observatories in which the magnetic instruments are mounted has proved of great advantage. The domes being revolvable, it is possible to direct an open panel to any part of the skies, thus permitting astronomical and magnetic observations being made with full protection to the observer and the instrument from wind and weather. Hitherto all such observations have had to be made on an open bridge.

Another important feature of the research work on this unique vessel is the developing and perfecting of a producer gas engine for auxiliary marine propulsion. The *Carnegie* has a non-magnetic plant of this kind of 150 horse power, sufficient to drive her at six knots in calm weather, or at about 144 knots per day at a total cost for coal consumed during the day of but seven dollars. Such difficulties as have been encountered thus far are mainly due to the non-magnetic metals which have had to be so largely employed. However, these difficulties are being successfully solved one by one. As a matter of fact, the *Carnegie* has entered and left every port thus far, under bare poles, with the aid of her auxiliary power and so likewise the vessel was swung during the trial tests at Gardiner's Bay and Falmouth, using only the auxiliary power. This vessel is the first sea-going one having such a plant.

The next table gives the results of the magnetic observations up to Falmouth.

The last three columns show the average errors of the best magnetic charts at present available. Glancing over them the following conclusions may be drawn:

1. From Long Island to some point off Newfoundland the charts used by mariners show too small westerly magnetic declinations (variations of the compass) by about one degree in the maximum, thereafter and continuing to England, the error changes sign, indicating that the charts give too large west magnetic declination, the maximum error being nearly one degree. Were there not such a systematic run in the errors they would not be of great importance to navigation, but as the sign is the same for great distances the general effect would be, in the present instance, to set the course of a vessel (when reliance must be put solely upon the compass and the log) always towards Newfoundland, whether the vessel came from the east or the west.

Magnetic Results obtained on the "Carnegie," September–October 18, 1909, in the Atlantic Ocean

No.	Latitude N.	Longitude W. of Greenwich	Date 1909	Declination West	Dip. N.	Hor. Int. C.G.S. Units	Corrections of Charts: Declinations	Dip	Hor. Int. C.G.S. Units
	°	°		°	°		°		
1	41.1	72.2	Sep. 1	11.4	72.1	.183	+0.4	+0.2	—.002
2	41.0	71.1	18	12.3	72.0	.182	+0.4	+0.1	—.003
3	40.9	70.4	14	12.9	......	......	+0.8	......	......
4	40.7	69.4	14	12.8	71.7	.185	+0.8	—0.1	.000
5	40.7	68.9	15	13.9	71.9	.182	+0.6	+0.2	—.003
6	40.9	68.4	16	14.4	......	......	+0.6	......	......
7	41.3	66.4	17	16.2	71.9	.181	+0.6	0.0	.000
8	42.0	61.1	20	20.2	......	.177	+0.9	......	000
9	42.5	61.2	21	20.8	......	.176	+0.9	......	+.003
10	42.8	60.8	21	21.4	72.5	.173	+1.1	+0.5	.000
11	43.8	58.9	22	23.7	72.7	.171	+1.1	+0.6	+.004
12	45.5	55.7	23	......	72.7	.169	......	+0.4	+.010
13	47.3	52.6	25	......	73.5	.158	......	+0.2	+.006
14	47.6	52.7	28	29.75	73.5	.159	0.0	—0.1	+.006
15	47.8	51.4	Oct. 3	30.4	......	......	0.0	......	......
16	48.2	50.4	3	......	73.5	.157	......	—0.2	+.008
17	48.4	48.0	4	31.8	......	......	+0.3	......	......
18	48.5	47.7	4	31.8	73.0	.161	+0.1	—0.1	+.011
19	48.7	46.5	5	31.8	......	......	—0.2	......	......
20	48.9	45.5	5	32.1	72.5	.161	—0.2	—0.2	+.010
21	49.6	37.5	7	......	71.2	.168	......	0.0	+.014
22	50.3	32.1	8	30.2	70.7	.171	—0.4	—0.3	+.014
23	50.6	28.8	9	29.0	......	......	—0.8	......	......
24	50.6	24.0	10	26.6	......	......	—0.8	......	......
25	50.6	22.2	10	......	69.2	.174	......	—0.3	+.008
26	50.5	19.2	11	24.5	......	......	—0.2	......	......
27	50.3	17.2	11	22.9	68.3	.180	—0.3	+0.1	+.006
28	49.9	11.9	12	20.3	67.4	.185	—0.6	+0.4	+.006
29	49.6	9.3	13	19.7	......	......	+0.2	......	......
30	49.5	7.5	13	18.6	66.8	.189	—0.1	+0.2	+.001
31	50.0	5.0	14	17.5	......	......	0.0	......	......
32	50.1	5.0	18	17.8	66.5	.187	+0.2	+0.2	—.002

No. 1 at Gardiner's Bay; No. 14 at St. Johns, N. F.; No. 32 in Falmouth Bay, England.

2. The chart errors in dip may amount to one half degree.

3. The chart values of the horizontal intensity are in general too low, the error amounting at times to nearly one tenth part.

4. A part of the errors found in the three magnetic elements are due to secular variation.

SPECIAL ARTICLES

THE PLEISTOCENE OF THE MISSOURI VALLEY

IN the course of his recent field studies for the Iowa Geological Survey in the Missouri Valley in western Iowa and eastern Nebraska, the writer was able to determine the following succession of Pleistocene formations:

1. The oldest drift sheet known in Iowa, to which the names pre-Kansan, sub-Aftonian, Albertan and Jerseyan have been applied, is exposed to a depth of more than fifteen feet, and may be traced along the foot of the bluffs for several miles on both sides of the Missouri near Omaha and Council Bluffs.

The terms pre-Kansan and sub-Aftonian have been applied merely to designate the relative position of this drift sheet. The Albertan deposit is not now regarded as a drift, and moreover neither the Albertan nor the uncertain Jerseyan can be correlated with the sub-Aftonian of Iowa. This drift has now been found in various parts of Iowa, Missouri and Nebraska, and probably in South Dakota, but nowhere does it reach such development as in the region under discussion.

Because of the great extent of this formation, and the fact that it can not be correlated with any named horizon, it is proposed that the name *Nebraskan* be applied to it.

The typical exposures above Florence and in South Omaha in Nebraska, and about four miles above Council Bluffs in Iowa, have been noticed by geologists, but the deposit was referred to the Kansan, or was identified as Carboniferous shale.

The Nebraskan consists of a dark, bluish-black tough joint clay which breaks up into very small blocks upon exposure to the air, and through which are scattered small boulders and pebbles which are also mostly dark in color.

2. Upon the Nebraskan, but sharply separated from it, rests a deposit of Aftonian sands and gravels. This is very commonly exposed on both sides of the river and reaches a thickness of more than 30 feet. In its lower part the gravels are often cemented into conglomerates to a depth of several feet.

Fine exposures of Nebraskan and Aftonian (the latter consisting of gravels, sands and sometimes silt) occur on both sides of the river, but those which appear along the Chicago Northwestern Railroad between Council Bluffs and Crescent are especially fine.

The Aftonian is the water-bearing stratum, and everywhere springs and seepy places abound at its base.

3. At several points in this region Kansan drift rests unconformably upon the Aftonian. It is the typical bluish Kansan with an abundance of calcium carbonate in streaks, cloudings and concretions.

4. Perhaps more frequently, in the immediate vicinity of Omaha and Council Bluffs, the Aftonian is followed immediately by a deposit of joint clay which frequently shows stratification, and often contains sand and pebbles in its lower part. This is the deposit which the writer designated as the *Loveland*,[1] from the type exposure at Loveland, Iowa. Great deposits of Loveland, often exceeding 30 feet in thickness, occur on both sides of the river.

This formation, which probably belongs to the period of the melting of the Kansan ice, is of especial interest because it has usually been referred to loess, from which it differs in its joint clay texture, usually reddish color, absence of fossils, and frequent occurrence of pebbles and coarse sand-grains in its lower part.

5. Overlying the Loveland, and usually separated from it quite sharply, is a bed of characteristic post-Kansan bluish-gray loess, which is usually fossiliferous. This is displayed at several points near Florence and in South Omaha.

6. Upon the post-Kansan loess lies a bed of later yellow loess, which is also often fossiliferous.

The total thickness of the two loesses in this vicinity does not reach 35 feet at any point observed on the Nebraska side of the river, and its thickness on the Iowa side is much less than has been reported, since the thickness of the Loveland must be deducted.

[1] *Bulletin of the Geological Society of America*, Vol. 20, 1909.

The discovery of the great deposits of Nebraskan, Aftonian and Loveland is especially important. A more complete discussion of these deposits will soon appear.

B. SHIMEK

IOWA CITY, IOWA,
December 2, 1909

THE BOSTON MEETING OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

REPORT OF THE GENERAL SECRETARY

THE sixty-first meeting of the American Association for the Advancement of Science was held in Boston, during convocation week, 1909–10; the first general session was called to order in Huntington Hall at ten o'clock on the morning of Monday, December 27, 1909, by the retiring president, Professor T. C. Chamberlin, who introduced the president of the meeting, President David Starr Jordan. Addresses of welcome were made, on behalf of Massachusetts Institute of Technology by President Richard C. Maclaurin and on behalf of Harvard University by Dean Wallace C. Sabine. President Jordan replied briefly on behalf of the American Association. Announcements were made by the permanent secretary, the general secretary and the local secretary, after which the general session adjourned.

The various sections and the affiliated societies met in their respective halls, according to the published program, the Massachusetts Institute of Technology and Harvard University having placed their lecture halls and laboratories freely at the disposal of the association.

The address of the retiring president of the association, Professor T. C. Chamberlin, was given in Sanders Theater of Harvard University, on the evening of Monday, December 27, the subject being, "A Geologic Forecast of the Future Opportunities of our Race." This address was preceded by an address of welcome to Harvard University by Professor F. W. Putnam, and was followed by a reception given by the corporation of Harvard University to the members of the association and the affiliated societies and their accompanying ladies, in Memorial Hall.

The registered attendance of members of the association was 1,140, the largest in the history of the association. The registration by sections was as follows: A, 106; B, 124; C, 200; D, 36; E, 166; F, 218; G, 132; H, 92; I, 12; K, 50; L, 104. The registration of members of affiliated societies at the association headquarters was only 166. This conveys no meaning with regard to the attendance of affiliated members, as one instance will show; the registration at the headquarters of the American Chemical Society was 558, while only 200 registered as belonging to Section C of the association. No doubt the attendance of other affiliated members was large, and no registration was secured. It seems, therefore, that the attendance of scientific men may have exceeded 2,000.

GENERAL EVENTS

On Tuesday evening, December 28, a public lecture complimentary to the citizens of Boston, was given by Dr. C. W. Stiles, on "The Hookworm Problem in this Country in Reference to Public Health."

On Thursday evening, December 30, under the auspices of the Entomological Society of America, a lecture was given by Dr. John B. Smith on "Insects and Entomologists: Their Relation to the Community at Large."

A reception by the president and corporation of Massachusetts Institute of Technology to the members of the association and affiliated societies and their accompanying ladies was given on the afternoon of Wednesday, December 29.

A reception by President and Mrs. Maclaurin was given to the visiting physicists and their ladies, at their home on the afternoon of Thursday, December 30.

On the afternoon of Friday, December 31, a lecture was given by Dr. Percival Lowell on "The Canali Novæ of Mars."

The business meeting and banquet of the Society of the Sigma Xi were held on the afternoon and evening of Wednesday, December 29.

There were many dinners arranged for groups of members, such as mathematicians and astronomers, physicists, chemists, geologists, zoologists and entomologists, anatomists and physiologists; there were many less formal but very pleasant "smokers" and other gatherings at various hotels and club houses.

ITEMS OF GENERAL INTEREST FROM THE PROCEEDINGS OF THE COUNCIL

The council met at nine o'clock in the morning, on Monday, Tuesday, Wednesday, Thursday and Friday, December 27 to 31.

At these meetings 57 new members were elected. A much larger number had been elected quite recently, and should be considered as being elected at the Boston meeting. The membership is now more than 8,000.

The council elected 229 fellows from those proposed by the various sections.

The following were elected foreign associates for the Boston meeting: Dr. Hans Hallier, of Leyden; Mr. J. J. Taudin-Chabot, of Holland; Professor Franz Weidenreich, of Strassburg; Professor C. Runge, of Göttingen.

The council was authorized to elect to membership scientific men of Central and South America.

The resignation of Mr. R. S. Woodward as chairman of the committee on policy was accepted, and Professor E. L. Nichols was elected to fill the vacancy in the committee on policy.

The resignation of Mr. R. S. Woodward from the committee on organization and membership was accepted, and Dr. W. H. Welch was appointed to the committee as chairman.

It was decided that at this Boston meeting the program be given to members of the association only at the time of registration, and that persons not members be charged 25 cents for each copy.

The committee on the relation of plants to climate reported progress.

It was resolved that the inquiry regarding the cost of publication, distribution and use of publications of American scientific societies should be extended.

Grants of $75 each were made to the Concilium Bibliographicum Zoologicum, Dr. W. P. White, Professor G. J. Peirce and Professor T. D. A. Cockerell.

It was resolved that each recipient of a grant be asked for an itemized statement of expenditures.

It was resolved that the American Association for the Advancement of Science gives its approval to the general plan of the George Washington Memorial Association to collect funds for the purpose of erecting a building in the city of Washington adapted for a meeting place for national and other scientific societies, and other organizations, and that a committee of five be appointed to assist in the effort.

It was resolved, that with a view to the proper conduct of such investigations as will aid in lessening the waste of life and resources which now characterizes the mining industry of the United States, the American Association for the Advancement of Science respectfully urges the Congress of the United States to establish, during its present session, a national bureau of mines. Resolved, that copies of this resolution be sent to the Speaker of the House of Representatives, the President of the Senate and the President of the United States.

It was resolved that the American Association for the Advancement of Science approves the appointment of an eminent astronomer in charge of the Naval Observatory.

The permanent secretary was authorized to issue the volumes for the Baltimore and Boston meetings under one cover, with separate titles and indexes, but with only one list of members.

SECTIONAL MEETINGS

The meetings of the various sections, many in joint session with affiliated societies, were perhaps the most successful in the history of the association, as measured by the number of members attending, by the number and quality of the papers presented and by the interest with which the papers were heard and discussed. The number of papers presented before each section and its affiliated societies are approximately as follows: A, 37; B, 54; C, 254; D, 17; E, 141; F, 124; G, 122; H, 63; I, 17; K, 166; L, 30; total, 1,025.

It has been impossible to obtain a general report from every section, hence specific reports are not made here; the secretaries of the several sections will publish detailed reports.

GENERAL COMMITTEE

The general committee met at Hotel Brunswick, at 9:30 o'clock on the evening of Thursday, December 30. It was decided to hold the next meeting at Minneapolis, beginning, on the evening of Tuesday, December 27, 1910, with a general session of welcome, and the address of the retiring president. It was recommended that the meeting of 1911–12 be held in Washington, D. C.

The following officers were elected for the Minneapolis meeting:

President—Professor A. A. Michelson, University of Chicago.

Vice-Presidents and Chairmen of Sections:

Section A—Mathematics and Astronomy—Professor E. H. Moore, University of Chicago.

Section B—Physics—Dr. E. B. Rosa, Bureau of Standards, Washington, D. C.

Section C—Chemistry—Professor G. B. Frankforter, University of Minnesota.

Section D—Mechanical Science and Engineering—Professor A. L. Rotch, Blue Hill Meteorological Observatory.

Section E—Geology and Geography—Dr. John M. Clarke, state geologist of New York, Albany, N. Y.

Section F—Zoology—Professor Jacob Reighard, University of Michigan.

Section G—Botany—Professor R. A. Harper, University of Wisconsin.

Section H—Anthropology and Psychology—Professor Roland B. Dixon, Harvard University.

Section I—Social and Economic Science—The Hon. T. E. Burton, Cleveland, Ohio.

Section K—Physiology and Experimental Medicine—Professor F. G. Novy, University of Michigan.

Section L—Education—President A. Ross Hill, University of Missouri.

Permanent Secretary (for five years)—Dr. L. O. Howard, Washington, D. C.

General Secretary—Professor Frederic E. Clements, University of Minnesota.

Secretary of the Council—Professor John Zeleny, University of Minnesota.

Secretary of the Section of Social and Economic Science—Fred C. Croxton, Washington, D. C.

Treasurer—The selection of a treasurer, to succeed President R. S. Woodward, was referred to the council, with power.

CLOSING GENERAL SESSION

The closing general session was held in Huntington Hall at 10 o'clock on the morning of Friday, December 31, 1909; President Jordan presided.

An amendment to article 23 of the constitution, introduced by Mr. Gulliver at the Baltimore meeting, and approved by the council, was adopted. The amended portion of the article reads as follows:

Article 23. Immediately on the organization of a section, there shall be a member or fellow elected by ballot, after open nomination, who, with the vice-president and secretary and the preceding vice-president and secretary and the presidents and secretaries of those affiliated societies which shall be designated by the council and the members or fellows elected by ballot at the four preceding meetings, shall form its sectional committee.

Reports were read by the permanent secretary, the general secretary and the local secretary.

By resolution of the council the president expressed the thanks of the association for the great hospitality, courtesy and privileges extended to the members of the American Association, in connection with the Winnipeg meeting and the western excursion of the British Association for the Advancement of Science.

It was resolved that the association express its hearty thanks to the many institutions and individuals of Boston and Cambridge and vicinity who have contributed to make the meetings so successful and enjoyable. The following were mentioned:

The corporation of Massachusetts Institute of of Technology.
The corporation of Harvard University.
The Museum of Fine Arts.
The Boston Society of Natural History.
Simmons College.
Boston University.
The local committee, Professor Charles S. Minot, honorary chairman; Professor H. W. Tyler, chairman of the executive committee.
Ginn and Company, donors of the Guide Books.
Boston Elevated Railway, for special cars.
The ladies' committee.
The citizens, for receptions, teas, musicales. dinners to restricted groups of members, too numerous for individual mention, but none the less sincerely thanked for the most generous hospitality shown throughout the meetings.

Dayton C. Miller,
General Secretary

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

The fifty-eighth regular meeting of the society was held at the Dewey Hotel, December 18, 1909, at eight o'clock P.M., Vice-president W. J. Spillman presiding. The following papers were read:

Peridermium strobi, an Importation from Europe: Dr. Perley Spaulding, U. S. Bureau of Plant Industry.

The European currant rust has two stages: one as a peridermium on the white pine, the other upon leaves of *Ribes*. The fungus is native in eastern Europe upon *Pinus cembra*, upon which it usually does little damage. Since about 1860 it has attacked *Pinus strobus*, *P. monticola* and *P. lambertiana*, all American species of pines. At present it is distributed throughout Europe, and is causing great damage to white pines in certain sections. In the spring of 1909 it was imported into the United States upon about two and one half million young white pine trees, being distributed in the states of New York, Vermont, New Hampshire, Massachusetts, Connecticut and Pennsylvania. Lots of trees from the same nursery are also known to have been imported into Ontario and Minnesota. During the past summer a special effort was made to remove the *Ribes*

from the vicinity of these plantations, and, it is believed, successfully, except in portions of Connecticut and in Ontario and Minnesota, which latter are inspected by local authorities. This work was carried on in cooperation with the forestry and plant pathological workers of the states involved. The disease is under control at present. The great problem now is to control or prevent further importations.

Chinese Perennial Wild Rice: C. S. SCOFIELD, U. S. Bureau of Plant Industry.

A plant closely resembling the wild rice of North America was collected about seventy years ago in the Trans-Baikal region of Siberia by a Russian botanist, Turczaninow. At that time the American wild rice was known to European botanists under the name *Hydropyrum esculentum*, and Turczaninow's plant, being regarded as congeneric with it, was named *Hydropyrum latifolium*. When Hackel monographed the grasses for Engler and Prantl, he decided that the Asiatic plant was only a variety of the American species, and, resurrecting the Linnæan name, *Zizania aquatica*, applied it to both.

Certain significant characters indicate that the Asiatic plant is a distinct species from the American. The American plant is an annual, being reproduced by seed which falls off into the water as soon as ripe. The Asiatic plant is perennial, capable of reproduction by rhizomes. There are also some differences in the floral characters, these being most apparent in the form of the floral pedicel and in the length of the awns of the glumes.

The Close Parallel between the Floras of Palestine and of California: Professor A. AARONSOHN, Haifa, Palestine. (By invitation.)

The speaker first exhibited a series of lantern slides showing the topography of Palestine, and the striking resemblances to that of California. Near the coast in each region is a range of low mountains beyond which lies a long interior valley having a range of higher mountains for its eastern wall. The direction of the prevailing winds being the same, the distribution of rainfall is closely parallel.

Herbarium sheets were then displayed showing numerous specimens of the same species from each region where they occur under very similar climatic and topographic conditions.

The conclusion was drawn that the present unfavorable aspect of agriculture in Palestine is not due so much to sterility of soil and aridity of climate as to the adverse influence of the form of government which has prevailed there. Under an improved régime it is anticipated that many of the economic plants that now flourish in California may be successfully introduced into Palestine.

In conclusion Professor Aaronsohn presented a second series of lantern slides showing agricultural conditions in Palestine to-day, and the vegetation of the sections visited in his explorations which resulted in the discovery of a wild wheat growing at high altitudes on sterile soil which he considers to be the prototype of our modern cultivated varieties. He found in this wild species a great diversity of types, some forms resembling *Triticum durum* and others *T. polonicum* and *T. monococcum*.

W. W. STOCKBERGER,
Corresponding Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 39th annual meeting of the society was held in the West Hall of George Washington University on December 18, 1909, President Wead in the chair. The meeting was devoted to the presentation of the usual annual reports and the election of officers.

The following officers were duly elected for the ensuing year:

President—R. S. Woodward.

Vice-presidents—C. G. Abbot, A. L. Day, L. A. Fischer, E. B. Rosa.

Treasurer—L. J. Briggs.

Secretaries—R. L. Faris, W. J. Humphreys.

General Committee—W. A. DeCaindry, Edgar Buckingham, P. G. Nutting, E. G. Fischer, R. A. Harris, W. S. Eichelberger, F. A. Wolff, G. K. Burgess, B. R. Green.

R. L. FARIS,
Secretary

THE WASHINGTON CHEMICAL SOCIETY

THE 194th meeting of the society was held at the George Washington University on Thursday evening, December 9, 1909. President Walker presided, the attendance being 55. Dr. Eugene T. Allen resigned as councilor of the American Chemical Society, and W. B. D. Penniman was elected in his stead. The following papers were read: "Estimation of Glycerine in Meat Preparations," by F. C. Cook; "Enzymes and their Relation to Soil Fertility," by M. X. Sullivan; "Detection of Colocynth Seed in Powdered Colocynth," by . K. Chestnut.

J. A. LE CLERC,
Secretary

THE AMERICAN CHEMICAL SOCIETY NEW YORK SECTION

THE third regular meeting of the session of 1909-10 was held at the Chemists' Club on December 17.

The following papers were presented: Morris Loeb and L. R. Morey, "Analyses of some Antique Bronzes"; Chas. Baskerville, "The Action of Radium Salts upon Ruby"; Chas. Baskerville and Reston Stevenson, "Apparatus for Drying Flasks."

Notice was given that members are invited to transmit to the secretary the titles of papers descriptive of new apparatus for presentation at the March meeting, which has been set apart for a symposium on new apparatus and lecture experiments.

C. M. JOYCE,
Secretary

THE ASSOCIATION OF TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND

The thirteenth meeting of the association was held at the College of the City of New York on Saturday, December 4.

The day was given up to the reading of two papers, "Mathematics in the Ethical Culture High School," by Charles B. Walsh, of New York City, and "Some Suggestions in the Teaching of Geometry," by Isaac J. Schwatt, of the University of Pensylvania, and to the reports of the various committees. The most important reports were the report on the association publication, *The Mathematics Teacher*, by the editor, William H. Metzler, of Syracuse University, and the report of the committee on algebra syllabus, presented by the chairman, Gustave Legras, College of the City of New York.

Dr. Metzler's report showed that *The Mathematics Teacher* was unqualifiedly a success; letters of commendation are frequently received, the subscription list outside of the association is increasing, and the financial side is in surprisingly good condition.

The algebra syllabus was discussed in detail, and after some amendments, was adopted by the association. The committee was continued, with power to make any necessary alterations in the preliminary report, and to make out the syllabus for advanced algebra.

The association passed an amendment to the constitution providing for the election of the editors of *The Mathematics Teacher*, and then elected the following officers for the following year:

President—William H. Metzler, Syracuse University.

Vice-president—Daniel D. Feldman, Erasmus Hall High School, Brooklyn.

Secretary—Eugene R. Smith, Polytechnic Preparatory School, Brooklyn.

Treasurer—M. Edna Shaw, William Penn High School, Philadelphia.

Members of the Council—(two years) Paul N. Peck, George Washington University, Washington, D. C.; (three years) Howard F. Hart, High School, Montclair, N. J.; Isaac J. Schwatt, University of Pennsylvania.

Editor-in-chief—William H. Metzler.

Associate Editors—Eugene R. Smith; Jonathan T. Rorer, William Penn High School, Philadelphia.

The secretary was instructed to report for the association at the federation meeting in Boston, December 27, and the editors, with the retiring president and the newly elected treasurer, were appointed a committee to confer with other associations, and especially with the federation, on the question of official publications.

EUGENE R. SMITH,
Secretary

POLYTECHNIC PREPARATORY SCHOOL,
BROOKLYN

THE NEW YORK SECTION OF THE ASSOCIATION OF TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND

THE first meeting for the year 1909-10 of the New York Section of the Association of Teachers of Mathematics in the Middle States and Maryland was held Friday evening, November 12, at the High School of Commerce, New York City. The topic for the evening was "Mathematics for Service or for Culture." "Mathematics for Service" was presented by Dr. Ernest R. van Nardroff, principal of the Stuyvesant High School, New York City. Dr. van Nardroff spoke from the experience of an able physicist, and offered a course of study, including the topics of algebra, geometry, trigonometry, analytical geometry and the calculus, which are useful in physics. "Mathematics for Culture" was presented by Dr. William H. Metzler, professor of mathematics, Syracuse University, Syracuse, N. Y. That Dr. Metzler spoke convincingly, or that the opinion of the meeting was already formed was evidenced by the discussion that followed. This discussion was animated and largely in favor of pure mathematics for its own sake.

LAO G. SIMONS,
Secretary

SCIENCE

Friday, January 21, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

ENGINEERING AS A PROFESSION AND ITS RELATION TO THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE[1]

In considering what should be the topic of my brief address as retiring Vice-president of Section D of this association, the question of the relation of the profession of engineering to this association has been forcibly brought before my mind. A number of engineering subjects of interest suggested themselves, in regard to which I might perhaps be able to present to you ideas more or less novel and interesting; but all these subjects seemed, upon consideration, better suited to one of the professional engineering societies. I have therefore concluded to ask your attention for a few minutes to a consideration of the profession of engineering itself and its relation to the American Association for the Advancement of Science.

I do this, in the first place, because the profession is one in the standing and recognition of which I have the deepest personal interest, and, in the second place, because I have even within a few months been made to realize that many well informed people deny that engineering is a profession at all or the engineer a professional man in the proper sense of the term; and, in the third place, because the relation of the profession to this association seems to have long been a matter of doubt and

[1] Address of the vice-president and chairman of Section D—Mechanical Science and Engineering. American Association for the Advancement of Science, Boston, December 29, 1909.

uncertainty. Many people seem to think that the engineer is neither a scientist nor a professional man, nor yet a business man strictly speaking, but that he is something betwixt and between—some one to be employed for certain technical work.

According to the dictionary, a profession is defined as "a vocation in which a professed knowledge of some department of science or learning is used by its practical applications to the affairs of others, either in advising, guiding or teaching them, or in serving their interests or welfare in the practise of the art founded on it. Formerly, theology, law and medicine were specifically known as the professions, but as the applications of science and learning are extended to other departments of affairs, other vocations also receive the name. The word implies professed attainments in special knowledge as distinguished from mere skill; a practical dealing with affairs as distinguished from mere study or investigation; and the application of such knowledge to uses for others as a vocation as distinguished from its pursuit for one's own purpose.

Up to the present time the art involved in the work of engineering has been more recognized than the science. The engineer has been considered rather a builder than a scientific man, pursuing an occupation rather than a profession.

At a meeting of the council of the Institution of Civil Engineers of Great Britain held on December 29, 1827, it was *Resolved;* that Mr. Tredgold be written to, requesting him to define the objects of the Institution of Civil Engineers, and to give a description of what a civil engineer is, in order that this description and these objects may be embodied in a petition to the Attorney General in application for a charter." At the following meeting of the council, on January 4, 1828, a communication from Mr. Tredgold was read and entered in the minutes, bearing the title: "Description of a Civil Engineer, by Thomas Tredgold, Hon. M.Inst.C.E.," as a result of which the charter of the institution describes the profession of the civil engineer as "the art of directing the great sources of power in nature for the use and convenience of man, as the means of production and of traffic in states for both external and internal trade, as applied in the construction of roads, bridges, aqueducts, canals, river navigation and docks, for internal intercourse and exchange; and in the construction of ports, harbors, moles, breakwaters and lighthouses; and in the art of navigation by artificial power for the purposes of commerce, and in the construction and the adaptation of machinery, and in the drainage of cities and towns."

Since Tredgold's time, however, fields then unsuspected have been added to the profession of engineering, amply justifying the prediction that he made, that the extent of the profession "is limited *only by the progress of science*," and that "its scope and utility will be increased with every discovery in philosophy, and its resources with every invention of the mechanical or chemical arts, since its bounds are unlimited, and equally so must be the resources of its professors."

But in order to sketch even inadequately the scope of engineering, I must ask you to follow with me briefly the historical development of the profession.

The vocation of engineering is as ancient as any of man's occupations. No doubt from the earliest times man has been subject to disease, and *the healing art* in more or less crude form has been practised; man, naturally a quarrelsome animal, has also from the earliest time engaged in disputes with his neighbors, and in more or less crude form the *law* has had to be ad-

ministered; and, once more, from the most primitive times, man has realized the presence of some supernatural power, which the *priest,* if only under the title of "medicine man," has endeavored to propitiate. But clearly, man has always required water and food, and has dug wells and employed crude means for raising water and of growing crops. He has also needed habitations, and has required the services of men to build them, so that the hydraulic and the structural engineer or architect may at least claim that their profession is as old as any.

As civilization developed, the work of the engineer or builder developed equally. The Assyrians and Babylonians built arches and bridges, the inhabitants of India built great reservoirs, the Egyptians built pyramids, the Romans built roads, bridges, aqueducts, baths and other important works, many of them of great extent and requiring great skill. But when we read that the construction of one of the pyramids of Egypt required the labor of 360,000 men for twenty years, we see that the work of the engineer was not precisely directed to the uses of others, and we realize the crudeness, in some respects, of the civilization which would permit such waste of useful effort. During the middle ages, with the neglect of learning, engineering declined, but with the revival of learning in the sixteenth century it took on new life, and since that time, with the advance of science, it has progressed probably more rapidly than any other field of activity.

During the early development of the profession, engineering came to be divided into two kinds, civil and military, the latter being concerned with fortifications and with means of offense and defense, while the former included all other applications of the building art. Up to nearly the end of the eighteenth century, Tredgold's definition was somewhat inapplicable, inasmuch as the *sources of power* in nature were not understood, and could be utilized only to a very small degree. Up to that time, engineering comprised mainly the construction of roads, canals and bridges, the improvement of harbors, river works, the construction of docks, and the supplying of towns and cities with water. The state of the art only allowed of the construction of bridges of very short span, of either stone or wood, since iron had not yet been brought into use, and ferries were generally employed in crossing streams too deep for fording. The steam engine was known only in a very crude and uneconomical form, the weaving of cloth was almost all done by hand, there was little transportation except by sea, cities were not drained or lighted by gas, the applications of electricity were, of course, unknown, navigation by water was entirely by means of sailing vessels or with oars, and the only form in which iron was used to any extent was in the form of cast iron.

But before the end of the eighteenth century there came a remarkable series of mechanical inventions—the spinning jenny by Hargreaves, the spinning frame by Arkwright, the mule by Crompton, the power loom by Cartwright, the modern steam engine by Watt, the puddling process for making wrought iron by Cort, and others. These were followed, in the first third of the eighteenth century, by the development of the steam locomotive by Stephenson, of the steamboat by Fulton, by the inauguration of the era of railroads, beginning for all practical purposes with the victory of the "Rocket" in the competition at Rainhill in 1829, and by the further great improvements in manufacturing, and in the production of iron and steel.

It was just at this time, when the minds of all were filled with the inventions of Watt and of Stephenson, that Tredgold gave his definition, clearly showing the tremendous influence held at that time by the subject of *power*. These great developments greatly enlarged the field of engineering, and gave birth to a new class of engineer—the railroad engineer. They led also to the differentiation of the mechanical engineer from the civil engineer. Since that time the mechanical engineer has claimed as his special field the development and use of power in all its forms, including the generation of power from the combustion of fuel and the flow of water, by means of the various types of engines and water wheels, the transmission of that power from point to point by means of belting, shafting or other means, and the utilization of that power by machinery. There is hardly a field of human industry, therefore, which is not dependent upon the mechanical engineer, because all manufactured articles depend upon power in some application, and upon machinery operated by power. The field of the modern mechanical engineer, however, not only covers the department of power and its applications—in manufacturing, in the steam locomotive, in the steamship—but it is also held to include the construction of mills, and all applications of steam and heat, such as heating, ventilation, lighting, refrigeration, ice making, elevators and so on.

But notwithstanding the differentiation from it of the field of the mechanical engineer, the field of the civil engineer was itself enlarged by the progress of science and invention. The great impetus given to manufacturing rendered necessary the distribution of the raw material and of the manufactured products. Transportation engineering was enormously increased in its scope, and the new profession of the railroad engineer was brought into existence. Roads and canals, harbors and docks were built with unexampled rapidity and river improvements were extensively carried on. At this time the increasing use of canals gave occasion for the celebrated remark of Brindley, the great canal engineer of England, himself an untutored genius, who, when asked what the use of a river was, replied "to supply canals with water." At the same time the economical production of wrought iron rendered possible the construction of bridges of unexampled span.

By this time had begun one of the greatest sociological movements which characterizes the present time, namely, the increasing congregation of people in cities. At the beginning of the nineteenth century only 3 per cent. of the population of the United States lived in cities, while at the present time the urban population is over 33 per cent. of the total. This phenomenon, during the last half of the century just passed, has led to the differentiation of another field of engineering, namely, that of the sanitary engineer, whose specific province it is to deal with the problems of water supply, drainage, the disposal of refuse, the purification of water and sewage, the sanitation of dwellings, and the various other problems resulting from this congestion of population.

Improvements, also, in chemistry and in metallurgy, have given rise to still other distinct branches of engineering, namely, mining engineering and metallurgy, the scope of which I will not endeavor here to sketch.

Again, the field of the mechanical engineer has during the past quarter of a century become subdivided, owing to the discoveries in electricity. Steam and water are no longer used simply to propel steam

engines or water wheels, producing power to be used on the spot. Steam or other engines, and water wheels, now drive electric generators, the currents from which are transmitted long distances, sometimes as great as 200 or even 300 miles, by means of transmission wires, to be again transformed by electric machinery and used for the production of light or for other purposes. The telephone and the telegraph have been discovered, electric cars have replaced the horse cars, and the passenger traffic of our steam railroads is in some cases being carried on by electric locomotives. Almost everything now-a-days *is* done or *can be* done by electricity, even to preparing our food and heating our houses. The electrical engineer, with a field already so wide that it is divided into specialties, is a product of the last twenty-five years.

Notwithstanding all these differentiations, even the field of the civil engineer keeps on increasing in scope. Coasts have to be protected from the sea, swamp and marsh lands reclaimed, large areas irrigated by artificial means, requiring the construction of great dams, the storing of immense quantities of water and the distribution of that water by means of canals into the uplands. Problems of urban transportation present themselves and must be solved by the construction of subways and tunnels, great railroad terminals have to be provided, and skyscrapers constructed.

Also, the development of electrical power, and the increasing scarcity and waste of fuel, has increased enormously the importance and value of water powers. The question of the discharge of rivers, the means of increasing it, of storing it so as to make it more regular from month to month, thus avoiding the damage due to floods, and increasing the power during dry seasons, the construction of dams and of the various works incident to the development of water powers, all these together with other problems now constitute a separate field, that of the hydraulic engineer. Water, at once the most valuable and necessary of the gifts of nature, and at the same time an enemy to be dreaded and feared, must be controlled and governed, so that communities may be supplied adequately with this necessity of life and the power generated by the rivers turned to the service of man. The laws of water flowing in conduits, through pipes and in open channels, must be studied and experimented upon, and the science of the laws of water—hydraulics—is steadily increasing in value and in importance.

But the field of the engineer is not yet exhausted. The increase in transportation by sea, the use of steel for ships, and the ever-increasing size of vessels, led to the profession of the naval architect, itself a large field, dealing with the applications of steel and other materials to the construction of vessels, and the proper equipment of these vessels. The naval architect builds the vessels, the marine engineer equips them with machinery and provides them with ventilating and other apparatus necessary to fit them for their use.

Finally, investigations in the various fields of applied chemistry, as for instance in the production of gas, in the manufacture of rubber, soap, glue and other materials too numerous to mention, have led in recent years to the formation of still another branch of the profession, namely, that of the chemical engineer, who deals with the applications of chemistry to the useful arts. To even enumerate the application of this science would tax your patience.

It will be evident from the foregoing brief review, that the field of engineering

is more extensive than that of any of the three so-called learned professions, and that the different branches of the profession differ from each other to such an extent as in some cases to have little in common, except a knowledge of the general principles of physics, chemistry, mechanics and other sciences. The profession of the physician, it is true, is divided into many specialties, but while the throat specialist deals with the throat, and the stomach specialist with the stomach, they are all dealing with the human body, in which all the parts and functions are closely interconnected; but even within the field of what is termed civil engineering, the railroad engineer and the irrigation engineer, or the railroad engineer and the architectural engineer, have little in common. Assuredly Tredgold was right when he said that the bounds of the profession are unlimited.

The work of the engineer as applied to any contemplated project consists essentially of four parts: first, to ascertain whether anything should be done, and if so, what should be done; second, to design and formulate the means to be employed in doing it; third, to select the proper materials; and, fourth, to carry on the actual work into execution. As the engineer's problem is to adapt the materials, the forces, the sources of power in nature to the use and convenience of man, it is clear that in order to fulfil his calling to the highest extent, the engineer should be scientifically trained, that he should be familiar with the fundamental principles which govern natural phenomena. Different branches of science are required in varying degrees in the different branches of the profession, but every engineer should know, and know thoroughly, the fundamental principles of chemistry, physics, mathematics and mechanics. The engineer should be possessed of the true scientific spirit, loving the study of science for its own sake as well as for its applications and trained to seek always the truth, the whole truth and nothing but the truth. But the work of the engineer deals not with science for its own sake, but with its applications to the practical affairs of men. The engineer must, therefore, be above all a *practical man*. He must not be a pure theorist, a dreamer, a visionary. He must see in his mathematical formulæ a meaning, and not a simple accumulation of letters. The engineer, then, must not only be a scientific man but he must be first and foremost a practical man. And on the whole, the latter is more important than the former, although it is in the proper combination of the two that the greatest excellence will result.

The engineer, unlike the true scientist or mathematician, does not work in his laboratory or his study; his work is with the affairs of men. Engineering is more than half business, and the successful engineer, therefore, must be to a considerable extent a *business man* and a *financier*. As already remarked, the most important problem, and the first he has to solve, is whether anything should be done in a given case, and if so, what? The engineer must not build a fine bridge with costly peculiarities, difficult to execute, for the sake of leaving a monument behind him. He must continually remember that engineering is not simply adapting the forces of nature to the use of man, but that it is adapting them economically and properly. More important than the question *how* a bridge shall be built is the question *whether* it shall be built. More important than the question *how* a railroad shall be located is the question *whether* it shall be located and *where* it shall be located. The decision of these questions requires finan-

cial and business ability of a high order, combined with a clear insight into the practical relations of things. The railroad engineer must study the manufacturing and economic conditions affecting a country through which a proposed railroad is to pass; he must consider the traffic on existing roads through that country, the relative importance of the cities, whether there is a possibility of increasing the agricultural or manufacturing product, whether the road should run in a comparatively straight line between two large towns or whether it should be diverted a number of miles in order to tap a smaller town or whether that smaller town should be reached by a branch from the main line; and many similar questions. It is clear that Tredgold's definition is faulty because it does not emphasize economy.

It is also evident that the engineer should have the large view. He has the opportunity to worse than waste the money of his employers. The engineer who concentrates his whole attention on details of construction may be a good subordinate—and even good subordinates are rare—but he will lack the essentials of the highest success.

Even after the construction of works is entered upon, the duties of the engineer will largely relate to business. He draws up the contracts for the work, estimates each month how much has been completed, certifies payments to the contractor, settles disputes, and in general attends to all the business, except legal matters, connected with the carrying out of the enterprise. He must be an organizer, and must know how large a force is necessary to superintend the work, and how to dispose it to the best advantage and with the greatest economy. It is evident, also, and this is extremely important, that the engineer must be a student of men—not a recluse, but a man among men; and upon his social qualities, upon his ability to get on tactfully with other men and his power of impressing his ideas upon others, will his success largely depend.

One of the most important functions of the engineer is to be able to determine the proper materials to use in his work, to know how to obtain them, and to know how to assure himself that he has obtained them. This function includes a wide range of scientific and practical knowledge. He must not only know the mechanical, chemical and physical properties of materials, such as building stones, timber, steel, iron, cement, paint, asphalt, etc., but he must know what particular material is best adapted to the particular work he has to do, and how to test it and so make sure that the desired qualities are obtained. Probably more engineering failures have been due to faults of material than to any other defect, although it is a common mistake of students to suppose that the work of the engineer is largely the designing of works by the use of mathematical formulæ.

It is evident from the foregoing that not only is the profession of the engineer a wide and varied one, but that it requires varied qualifications, and demands preeminently an all-round man. It must not be forgotten, however, that without the scientific training, or at least the scientific spirit, the engineer will not attain the highest success. It is also evident that the thoroughly trained and capable engineer will find many opportunities to make himself useful in scientific as well as in administrative positions. He will also find many opportunities for doing general public service to the state or nation. Different men have different ideals of success, but the highest ideal is the one which most involves the idea of public service. We have heard a great deal about our natural re-

sources and, indeed, we in this land have been favored in an exceptional degree. We have already done much toward the development of these resources. Our industrial progress in the last one hundred years has been unexampled. But with this great development has gone great waste and extravagance. Our natural resources are being dissipated at a rate which will cause the disappearance of many of them within a comparatively few years if the waste is not checked. To elaborate this subject would require a long time, but you may not be aware of the fact, to cite but one instance, that natural gas is to-day being wasted in this country to such an alarming extent that the waste would be sufficient to light every city in the United States having a population of over 100,000. The engineer is the man who *applies* the resources of nature. He must be the man who also *conserves* those resources. It is probably safe to say that upon him, more than upon any other man, depend the continuance and increase of our prosperity.

The law, medicine and theology have always been considered as the *learned* professions. They are the vocations for which men have been honored *on account of their brains*. After what has been said is it not clear that the engineering profession can claim this distinction to fully as great a degree? Assuredly, such would seem to be the case. But while the three so-called learned professions have been recognized as such for centuries, the profession of engineering, as already said, is the product of the last century and a half. For this and other reasons, it has not been recognized in the popular mind to the extent which its intrinsic importance and the excellence of its work justifies. This is, of course, perfectly natural. In the early days of engineering, centuries ago, the engineer was usually a man engaged also in some other vocation, frequently that of architecture, but sometimes that of the statesman, administrator, mathematician, lawyer, soldier or even priest. Archimedes was a mathematician, but he also built canals in Egypt and in his last days devoted his scientific knowledge to the defence of his native city of Syracuse against Marcellus. The Emperor Trajan built a remarkable bridge across the Danube; and Julius Cæsar built one across the Rhine; Leonardo da Vinci was not only poet, painter and sculptor, but also a civil and military engineer; and during the middle ages the building of bridges in Europe was undertaken by a monastic order known as the Brothers of the Bridge.

I maintain that the preceding discussion fully establishes the fact that engineering is a profession, that the engineer in the highest sense is a professional man, and further that he should be a scientist at heart. It is equally clear, however, considering the relation of the profession to business that many engineers may be purely business men, practising engineering not in the truly professional sense. This, however, is also true of the law, as many examples might be quoted to illustrate.

When this association was organized in 1848, the great development of engineering which has been sketched in preceding pages was just beginning, but had not progressed far. There were few engineering schools or engineering societies. In this connection the growth of engineering schools and of engineering societies is interesting. The oldest engineering society in this country is the Boston Society of Civil Engineers. It was organized July 13, 1848, and incorporated April 24, 1851. It held sessions until 1856, after which there was a gap until 1874, so that it is

really only during the past thirty-five years that the modern society has existed.

The American Society of Civil Engineers was founded in 1852 and held meetings until 1855, when there was a gap until reorganized in 1867. This society now numbers 4,847 members in all grades.

The American Institute of Mining Engineers was organized in 1871, the American Society of Mechanical Engineers as late as 1880 and the American Institute of Electrical Engineers in 1884.

In England, the first society of engineers was a club organized in 1771 by Smeaton and a few others who met at a tavern. Twenty years later it consisted of nearly twenty members, but of these only fifteen were engineers. A personal difficulty broke up the club, but it was reorganized a year later and existed as late as 1872.

The present Institution of Civil Engineers was an outgrowth from this society and was established January 18, 1818, the renowned Telford being the first president and holding that office from 1820 to 1834. Telford built roads and bridges, canals, river works, docks and lighthouses, drained fens and reclaimed the land from the sea. The railroad era was just beginning, and also that of the water supply, gas lighting and drainage of cities. In the time of Telford the institution never numbered more than 200 members, but between 1840 and 1860 two of the leading English railroad engineers, Robert Stephenson and I. K. Brunel, probably each had a corps of trained engineers under his control as large as the whole membership of the institution in its early days. The institution now has a total membership of 8,627 in all grades. This institution was the first professional body to publish discussions of its papers, others, like the Royal Society, publishing only the papers themselves.

At the time of the declaration of independence there were only two professional schools in the United States—the Medical College in Philadelphia (afterwards the Medical School of the University of Pennsylvania) and the Medical School of King's College (afterward Columbia University). The Harvard Medical School was established in 1782 by the appointment of Dr. John Warren as professor of anatomy and surgery. During the last century, medical schools sprang up with great rapidity, both connected with universities and independent, many of them with very low standards. In 1870, Harvard was the first to demand a new and much higher standard, followed only a few years ago by further raising the standard by requiring a college degree, or its equivalent, for entrance.

The first law school in America was not connected with any college and was established in 1784 at Litchfield, Conn., but was discontinued in 1833. The Harvard Law School was established in 1817, being the earliest connected with a university and authorized to confer degrees in law. In 1897 it was made a graduate school for which a college degree was required for entrance, or a degree of proficiency sufficient for entrance into the senior class at Harvard.

The Yale Law School was established in 1824; that of the University of Virginia in 1825, of the University of Cincinnati in 1833 and of Columbia University in 1858. In 1878, there were fifty law schools in the United States with a total of 3,012 students; in 1901 there were 86 law schools with a total of 11,883 students.

The first engineering school in this country was the Rensselaer Polytechnic Institute at Troy, which was organized in 1824. The Lawrence Scientific School of Harvard and the Sheffield Scientific School of Yale were organized in 1847, and these

were followed during the next twenty years by the Massachusetts Institute of Technology in 1865 and other institutions. Since that time, the number of schools and students has greatly increased, as shown by the following statistics relating to professional schools in 1905:

	Theological Schools	Law Schools	Medical Schools	Schools of Technology Conferring only B.S. Degrees
Number of institutions...	156	96	148	44
Teachers.......	1,094	1,190	5,465	1,865
Students.......	7,580	14,714	25,835	16,110

The engineering *societies* do not in any case require a technical training as a preparation for membership. The American Society of Civil Engineers requires for full membership that the candidate shall be at least thirty years of age, shall have been in the practise of his profession for ten years and shall have had responsible charge of work for at least five years. Graduation from a technical school is considered equivalent to two years of practical work.

A good illustration of the development of the engineering profession is found in the history of the noted French corps of government engineers known as the Corps des Ponts et Chausseès. It was in the time of Charles V. that professional engineers were first employed by the king to supervise public works, particularly roads, which were known as the king's highways. The corps experienced many vicissitudes, some rulers appreciating their work while others did not. In the time of Louis XIV., the engineers were pushed into the background, the king reserving his favor for the court architects. The architect, Mansard, was entrusted with the building of a bridge across the Allier at Moulins, but he was unacquainted with the principles of hydraulics and could not calculate the volume and force of the water, and did not know how to protect his bridge against floods, so that it collapsed a few years later. This disaster was favorable to the engineers, who pointed out that while it was the duty of architects to build fine palaces, engineers should be entrusted with the construction of public works where convenience and stability were of more importance than elegance. The Corps des Ponts et Chausseès was definitely and permanently organized between 1712 and 1716; and under Louis XV. the noted Ecole des Ponts et Chausseès was constituted by royal decree dated February 14, 1747. It was placed under the direction of the engineer Perronet, who besides other great works had built the beautiful Pont de la Concorde at Paris. At the beginning of the French Revolution, it was proposed to abolish the corps, but this move was defeated by Mirabeau, and, instead, the corps was reorganized by several decrees. The corps is now under the department of public works. Five sixths of its engineers come from the Ecole des Ponts et Chausseès, while one sixth come from foremen, who, after ten years' experience, are entitled to enter a competitive examination and if successful may be appointed engineers.

Perronet remained director of the school for forty-seven years after it was founded in 1747. He died February 27, 1794. The following year the Ecole Polytechnique was founded, giving a general scientific training preparatory to the engineering school. The course in the engineering school extends over three years, offering free tuition in all courses, and state pupils are chosen exclusively from those leaving the Ecole Polytechnique and receive a salary of $360 a year plus $10 monthly during their stay in Paris. During each vacation they are required to spend three and one half

months in practical work under the supervision of one of the engineers of the corps.

From these statements it is evident that engineering schools are of later growth than those in the other learned professions, which in Europe have been established for centuries, and in this country long antedated the technical schools. It is also clear that engineering societies are mostly of more recent origin than this association, and that they do not insist upon a technical or scientific education as a qualification for membership.

It is clear from what has been recited that with the great development of applied science, or engineering, has gone a corresponding development of engineering societies. Each separate branch of engineering is represented by a national society, and there are numerous smaller local societies. While in the old days the American Association for the Advancement of Science may have had attractions for engineers, and may have given them opportunities for scientific discussion of papers not otherwise to be obtained, even this is questionable, and it certainly is not now the case. It is safe to say that important engineering papers will not be presented to this society, or if so presented, will fail to be of their due influence. Section D, however, or what has corresponded to it, does not appear to have ever been of great importance in the American Association for the Advancement of Science. I have examined the records of the association from the beginning and it appears that few, if any, engineering papers of importance have been presented to it, except by title or on abstract, and that these have often been presented in full before professional engineering societies, or in the engineering papers. A majority of the papers before this section have been presented by a very small group of men, including professors in a few engineering schools and some men holding government positions. For many years no papers have been printed in full except the vice-presidential addresses, and in many instances the other papers have all been printed by title only. Even in the early days, or up to 1880, there were many years in which but one paper on applied science was presented, and there were nine years in which no such paper was presented. Section D was first constituted in 1882, although previous to this date the section of mechanical science had been recognized as a branch of the section on mathematics and physics. About this time Professors Trowbridge, Thurston and others began to take some active interest in the society, and their names with those of Burkitt Webb, Wood, Denton and some others are frequently seen in the list of authors, although none of their papers are printed in full in the proceedings. In five years since 1882 there have been no vice-presidential addresses; in the majority of the cases such addresses, like the present one, have not been upon engineering or even scientific topics, but have been distinctly general or educational in character. The attendance at the meetings of the section has, from what information I have been able to gather, been small, and the future of the section has long been a matter of doubt. Professor Storm Bull, in his annual address in 1899, expresses his regret at the somewhat prevailing feeling that the extinction of the section is imminent.

What, then, is the function of Section D as related to the profession of engineering? Has it a useful purpose to subserve?

As a comparatively new member of the association, I venture an opinion on this subject with diffidence, yet as an engineer of some years of experience, and with a somewhat close knowledge of a number of strictly professional societies, possibly it

may be proper for me to do so. In the first place, I confess that when I joined the society I did so not because of its relations to engineering, but because of my interest in some branches of science; not primarily in order to meet engineers or to hear engineering papers, for these ends can much better be obtained in connection with the professional societies, but to have the opportunity to meet men interested like myself in the various branches of pure science. I believe that the membership of this section will in the future, as in the past, consist largely of teachers of engineering who like myself recognize that the profession of engineering is founded upon the principles of science, and who desire to keep alive their interest in and contact with those scientific branches; and that the section can never become an effective means for the discussion of technical engineering subjects. From this point of view, then, I believe that the main benefit of this section, which I hope will continue, will arise in two ways: In the first place, it will be beneficial if its main activities are directed not toward technical engineering subjects, but toward subjects which are more scientific than technical. For instance, the subject of geodesy has not yet been made the basis of a national engineering society in this country, and, indeed, that subject is probably quite as much allied to the science of physics as it is to engineering. Such a subject might well be made a specialty of this section, for it is rarely that we find a discussion of geodetic subjects before any of the engineering societies.

Again, the subject of aeronautics, which I am pleased to see has been made an important feature of the present meeting of this section, seems a peculiarly appropriate field. It is perhaps a fair statement that this subject is as yet more a scientific and experimental one than an engineering one; at all events, it has not yet been taken up to any considerable extent by the engineering societies. Subjects, then, more purely of a scientific character and yet of such concrete nature that they are capable of practical utilization, or may form the basis of engineering applications, may well be emphasized in the meetings of this section.

We must remember that for the engineer, science will in most cases simply afford him a basis for his judgment rather than give absolute results. You have discussed this morning questions regarding the wind and the variation of its velocity and pressure with the height; but no matter how many observations you may make, or how many theories you may formulate, the engineer will still have to depend upon his judgment in providing for the wind pressure upon a modern skyscraper or Eiffel Tower.

In the third place, if I am right in considering that the members of this section, like myself, have their principal interest in the society because of their interest in certain branches of pure science, it would seem that the section might be of benefit if it could hold joint meetings frequently with other sections, and instead of attempting to present a long array of papers, should content itself with a very few having distinct relation to some particular topic assigned to the meeting. Certainly no session has been more interesting or, in my opinion, more profitable, than the joint meeting in Chicago, two years ago, with the mathematical section. Engineers, and particularly teachers of engineering, have, or should have, much in common with teachers of mathematics, chemistry and physics, and even with those in still more distantly related sections. And men in those other sections have, or should have, not less to gain from intercourse with us. My plea, then, is that the main benefit of Section D is not to be derived from its

activity as an association of engineers, that is, as a strictly or even quasi professional organization, but from its relations with the other sections, and that its own activities might well be somewhat curtailed if more intimate relations could be initiated and stimulated with those other sections; and that it should endeavor to present to its members not technical engineering subjects, but rather scientific subjects in branches seldom discussed in the technical engineering societies. Let us remember, then, that engineering is a profession, but that it is founded upon science; that the engineer should be at heart a true scientist, and thoroughly imbued with the scientific spirit. Further, that this association is not a professional society, but a scientific one, and that we come here rather as scientists than as engineers; that through our meetings and our contact with scientists in all branches, we may go forth to our daily practical and business work more thoroughly imbued than ever with a sense of the importance of our profession, and better able to apply economically the materials, forces and laws of nature in the service of man.

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THE CHEMICAL REGULATION OF THE PROCESSES OF THE BODY BY MEANS OF ACTIVATORS, KINASES AND HORMONES[1]

AT the time of Sir Charles Bell physiologists were beginning to realize the great importance of the nervous system as a mechanism for regulating and coordinating the varied activities of the body. To use his own expression, "The knowledge of what is termed the economy of an animal body is to be acquired only by an intimate acquaintance with the distribution and uses of the nerves." Since his time experimental investigations in physiology and clinical studies upon man have combined to accumulate a large fund of information in regard to the regulations and correlations effected through nervous reflexes. No one can doubt that very much remains to be accomplished along these same lines, but in recent years we have come to understand that the complex of activities in the animal body is united into a functional harmony, not only through a reflex control exerted by the nervous system, but also by means of a chemical regulation effected through the blood or other liquids of the organism. The first serious realization of the importance of this second method of regulation came with the development of our knowledge of the internal secretions during the last decade of the nineteenth century. The somewhat meager information possessed at that time in regard to these secretions developed in the fertile imagination of Brown-Séquard to a great generalization, according to which every tissue of the body in the course of its normal metabolism furnishes material to the blood that is of importance in regulating the activities of other tissues. This idea found a general support in the facts brought to light in relation to the physiological activities of the so-called ductless glands, and subsequently in the series of remarkable discoveries which we owe to the new science of immunology. In recent years it has been restated in attractive form by Schiefferdecker in his theory of the symbiotic relationship of the tissues of the body. According to this author we may conceive that among the tissues of a single organism the principle of a struggle for existence, which is so important as regards the relations of one organism to another, is re-

[1] Address of the vice-president and chairman of Section K—Physiology and Experimental Medicine. American Association for the Advancement of Science, Boston, December 28, 1909.

placed for the most part by a kind of symbiosis, such that the products of metabolism in one tissue serve as a stimulus to the activities of other tissues. If a muscle is stimulated to greater growth by an excess of functional activity the substances given off to the blood during its metabolism act favorably upon the growth of other muscles which are not directly concerned in the increased work, or upon the connective tissue surrounding and permeating the muscular mass; and conversely, the development of connective tissue from any cause aids directly by its secretions or excretions in the growth of the muscle. There is thus established a *circulus benignus* by means of which each tissue profits from the functional activity of its fellow tissues. From many sides and in many ways facts have been accumulating which tend to impress the general truth that the co-activity of the organs and tissues may be controlled through chemical changes in the liquid media of the body, as well as through nerve impulses, but in physiology at least we owe the definite formulation of this point of view to Bayliss and Starling. Through their investigations upon secretin they obtained an explicit example of how one organ controls the activity of another organ by means of a specific chemical substance given off to the blood. Other facts known in physiology in regard to the internal secretions were easily brought into line with this definite instance furnished by the secretin, and Starling's convenient term of "hormone," as a general designation for such substances, has served to give a wide currency to the conception. The word and the generalization implied by it have been adopted by investigators in many fields of biological research to explain phenomena of correlation which heretofore it has been impossible to bring under the general rubric of nervous reflexes; phenomena which in fact it has been difficult to express clearly in any precise way such as might serve to stimulate direct experimental investigation. An interesting example of this application of the term and the idea contained in it is found in the theory advanced by Cunningham to explain the development and inheritance of secondary sexual characteristics. This author constructs a system of hypothetical hormones which, if present, would account not only for the development of the secondary sexual characters, as the result of the action of specific hormones furnished by the reproductive cells, but would also make conceivable a method by which these secondary characters, like other somatogenic characters, might affect the germ cells in turn in such a definite way as to be transmitted to the following generations. It is not my purpose to criticize this or similar theories. They will doubtless serve a good purpose in stimulating and directing investigations. It does, however, seem probable that the term hormone, like some of the useful terminology of immunology, will be overworked, and that investigators may deceive themselves as well as others when they conclude that any given relationship is an example of hormone regulation. It has occurred to me that it may be useful in connection with this symposium upon the internal secretions to review very briefly the state of our knowledge in regard to the hormones, with the purpose of discussing somewhat the probable nature of their action and the extent of their distribution.

In treating this subject one must consider also the more or less nearly related instances of combined activity of a chemical sort which are expressed by such terms as chemical activators, kinases and co-ferments. These terms like that of hormone are relatively new, they have been brought

into existence by investigators to explain or to express special reactions connected with metabolism and particularly with the action of ferments. Their precise meaning must be determined by further knowledge of the facts they are intended to describe, but something may be gained by attempting to define them as they are used in physiology at present. The word activator has reference to the fact long known that the ferments, or some of them at least, are secreted in an inactive form, a proferment, which is activated or converted to an active form by a reaction with some definite substance produced elsewhere in the body. Pepsin, for example, is secreted as pepsinogen and is activated to pepsin by the hydrochloric acid formed by other gland cells. Calcium salts are necessary for the activation of the prothrombin, and enterokinase or calcium plays a similar rôle with reference to the trypsinogen. It is to be noted that reactions of this kind are not confined to the ferments. The typical hormone, secretin, exists in the form of an insoluble prosecretin which may be activated by acids, and, according to Delezenne, calcium takes an essential part in the activation of enterokinase, in somewhat the same way as occurs with thrombin. The nature of these activating reactions is not known. The view has been proposed that the inorganic constituents involved, the hydrochloric acid and the calcium for example, act as catalyzers which accelerate a reaction that would occur without their assistance. There is, however, no evidence to show that thrombin is formed in any amount in the absence of calcium salts, nor that pepsinogen yields pepsin without the presence of acids. As Bayliss has pointed out, these reactions belong to the irreversible group, and it is possible that the activator or one of its constituents is represented in the composition of the active substance that is formed. However that may be, it is to be noted that the process of activation is an instance of chemical coordination. The pepsin formed in one kind of gland cell is activated by the acid produced in a different variety of cell. The hydrochloric acid produced in the stomach is carried into the intestine with the flow of chyme and there activates the prosecretin of the intestinal epithelium either directly or indirectly. One tissue, in other words, through its products of metabolism aids another tissue in the performance of its functional duties.

The term kinase is used at present in animal physiology in connection with two reactions only. In both cases it refers to an activating process similar to those just considered, except that the activator is a colloidal substance of unknown composition. The pancreatic juice poured into the duodenum contains its proteolytic enzyme in the form of a trypsinogen which is activated immediately to trypsin by contact with the duodenal epithelium or with the secretion furnished by this epithelium. The activating substance is designated as enterokinase. It is present normally in the intestinal juice formed in this part of the alimentary canal, or it may be obtained in extracts of the mucous membrane of the duodenum or jejunum. According to Pawlow, however, the intestinal secretion obtained by direct mechanical stimulation of the epithelium is lacking in enterokinase. This latter substance is produced in fact only under the influence of some constituent of the pancreatic juice, possibly the trypsinogen itself. In other words it would seem that the enterokinase must itself be activated before it can fulfill its functions as an activator of the trypsinogen. The chain of inter-related processes occurring at this point in the act of digestion becomes somewhat intricate, as fol-

lows: Hydrochloric acid formed in the stomach and brought into the intestine with the chyme stimulates the epithelial cells of the intestine to form secretin and to pass it into the blood. The secretin conveyed by the blood to the pancreas stimulates this organ to secrete pancreatic juice. The pancreatic juice is carried to the duodenum and stimulates the epithelial cells to form enterokinase which then activates the trypsinogen to trypsin. Assuming that all of these steps are verified by future work, we have in this series of events an excellent example of chemical coordination, that is to say, of coordination effected by chemical stimuli conveyed from one organ to another through the liquids of the body. It may be noted in passing that the epithelial cells of the duodenum under the influence of acids or soaps form an internal secretion, the secretin, while under the influence of the pancreatic juice they produce an external secretion, the enterokinase. It is of course possible that these two different functions are subserved by separate cells, but so far as our evidence goes at present we must infer rather that one and the same epithelial cell gives either an internal or an external secretion according to the nature of the chemical stimulus acting upon it. While there can be no doubt at all of the existence of enterokinase and of its wonderful effect in activating almost instantaneously the trypsinogen of the pancreatic juice, much uncertainty prevails as to its nature and its mode of action. Pawlow thought that it belongs to the group of enzymes and this view has been supported in an almost convincing way by the experiments of Bayliss and Starling. In accordance with this view it is found that the substance exhibits a certain degree of thermolability, being destroyed at a temperature of 67 to 70° C., although in this respect it is less sensitive than most of the well-known enzymes. From this standpoint the action of the enterokinase upon the trypsinogen would come under the general head of catalytic reactions, but here again it is to be observed that its action differs from that of the other enzymes in the great rapidity with which it is completed, a rapidity quite comparable to that of ordinary chemical reactions. Other observers (Dastre and Stassano, Hamburger and Hekma, Cohnheim) have contended that the enterokinase unites permanently and quantitatively with the trypsinogen, after the manner of an amboceptor and complement, to form a new and active compound, the trypsin, and the whole reaction has been still further complicated by the discovery (Delezenne) that the trypsinogen may be activated by calcium salts without the presence of enterokinase. The action of the calcium requires some time for its development but when it occurs it takes place not gradually but abruptly, just as in the case of the activation produced by enterokinase. The further fact stated by Delezenne that the enterokinase itself needs the presence of calcium salts before it acquires the property of affecting trypsinogen suggests naturally the thought that the action of the enterokinase may be at bottom another case of calcium activation. Pozerski states that in the inactive pancreatic juice obtained by injections of secretin calcium is not present; whereas in the active juice following upon the use of pilocarpin, calcium is contained, and the digestive action of the juice runs parallel with the content in calcium. But whether the enterokinase acts as a ferment, or an amboceptor, or a calcium carrier it constitutes a special type of organic activator and this fact suggests the possibility that other processes in the body may be controlled by similar compounds

At present only one other organic activator of this kind has been described, namely, the thrombokinase of blood coagulation. This hypothetical substance is given great importance in the theory of coagulation proposed by Morawitz. According to this theory the blood corpuscles under abnormal environment yield an unknown substance of colloidal nature which together with calcium is necessary for the complete activation of thrombin, and therefore for the clotting of blood. A similar kinase is furnished by the tissues in general, so that blood escaping from a vessel and coming in contact with the surrounding tissues obtains from them a kinase which accelerates the process of clotting. The evidence for the existence of this kinase is far less satisfactory than in the case of the enterokinase, indeed one may have serious doubts whether the facts at present warrant the assumption that a specific organic kinase must cooperate with the calcium in activating the thrombin, but if the idea is demonstrated to be correct it will furnish another very interesting example of the way in which chemical coordination may be employed in the body. In this case the blood may be supposed to stimulate the tissue cells to form a substance not directly of importance to their own activity, but which initiates the coagulation of the blood, stops the hemorrhage and thus saves the organism from destruction. The series of events is quite parallel to that described for the pancreatic juice and the enterokinase.

In addition to the activators of the inorganic and the colloidal type there is perhaps a third kind of activation exemplified in the substances known as coenzymes or coferments. This term may be used to define that kind of cooperative activity between an enzyme and some other noncolloidal substance which we see illustrated in the influence of the bile salts upon pancreatic lipase. The process differs from activation of a proferment to a ferment only in that the combination of the enzyme with its activator is dissociable instead of being permanent. By dialysis or otherwise the coenzyme can be separated from the enzyme and the action of the two may be tested separately or in combination. Perhaps this species of activation may be more common in the animal body then we have supposed. Bierry and Giaja have shown that the amylase of pancreatic juice loses its diastatic action entirely when dialyzed and this power or property is restored upon the addition of sodium chloride. It would seem from their experiments that the amylase is active only when combined with an acid ion, such as Cl or Br and the transition from one form to the other, from the active to the inactive or the reverse is easily accomplished. No one can doubt that all these forms of chemical activation are allied in a general way to the more interesting and obvious mode of chemical coordination illustrated by the hormones. Starling defines hormones as chemical messengers which formed in one organ travel in the blood stream to other organs of the body and effect correlation between the activities of the organ of origin and the organs on which they exert their specific effect. Such substances belong to the crystalloid rather than the colloid class, they therefore are thermostable and do not act as antigens when injected into the living animal. The general idea of this definition is clear and most suggestive, but in its details it is made especially to suit the case of secretin, and therefore may not fit so well for other substances of like physiological value. Conveyance through the blood stream, while certainly the most common occurrence for this class of bodies, ought not to constitute an essential part of their

definition. The secretin formed in the intestinal epithelial cell is conveyed to the pancreas in the blood and brings about a correlation between the activity of this gland and that of the duodenum, but on the other hand some substance contained in the pancreatic juice and conveyed to the duodenum in the stream of secretion excites the formation of the enterokinase, and thus correlates the activity of the duodenum with that of the pancreas. The two actions seem to be so similar, except for the means of transport, that one would naturally put them in the same class. By the same reasoning we might be justified in designating the hydrochloric acid of the gastric juice as a hormone in reference to its action in causing a formation of secretin in the epithelial cells of the duodenum. One can imagine that a similar transportation may occur in the secretions of the reproductive or respiratory passages, in the cerebro-spinal fluid, as seems to be the case for a time at least with the secretion of the pars intermedia of the pituitary gland, or even along the axial stream of a nerve fiber. If, as seems to me, the idea of correlation or coordination is the essential point rather than the assumption that the product must constitute an internal secretion, we might modify the definition so far as to designate as hormones those substances in solution which, conveyed from one organ to another through any of the liquid media of the body, effect a correlation between the activities of the organ of origin and the organ on which they exert their specific effect. As regards the nature of the action of the hormones on the organ affected we know too little to make any safe generalization. In the case of the secretin it seems most probable that the hormone arouses the pancreatic cells to an act of secretion and therefore it has in this instance the value of a chemical stimulus. But in other cases the effect of the hormone may be rather of the nature of an activation. This at least would seem to be true for the hormone, of unknown nature, given off by the pancreas and concerned in the glycolysis of sugar in the organism. The effect of the hormone adrenalin upon the musculature innervated by the sympathetic system may also be of the nature of an activation rather than of a chemical stimulation.

The substances of known composition which may be regarded as playing the rôle of hormones are few in number, three or four at most as follows: First, the carbon dioxide formed in the tissues, particularly in muscle during contraction. It seems agreed now that the carbon dioxide acts as the normal stimulus to the respiratory center. When produced in the working muscles in such quantities as to raise perceptibly the carbon dioxide tension in the alveoli of the lungs and the blood of the pulmonary veins, the respiratory center is excited to greater activity and the excess above the normal contents is thereby removed; second, the adrenalin of the adrenal glands which in some way, directly or indirectly, makes possible the full functional activity of the involuntary musculature of the body; third, the hydrochloric acid produced in the stomach which stimulates the formation of secretin in the duodenal epithelium; and fourth, possibly the iodothyrin of the thyroid gland with its dynamogenic effect upon the neuromuscular apparatus of the body. In addition there are a number of hormones of unknown composition which have been either proved or assumed to exist, and which are held responsible for certain well known correlations of function. The pancreatic secretin formed in the epithelium of the duodenum or jejunum which stimulates the flow of pancreatic secretion; the gastric

secretin formed in the plyoric mucous membrane which gives rise to the chemical secretion of gastric juice; a secretin formed in the duodenal epithelium which stimulates the formation of intestinal juice in the following segments of the intestine; unknown hormones of pancreatic origin which determine the absorption activity of the intestinal epithelium; vaso-dilator hormones formed in tissues in functional activity and which have a specific effect upon the vessels of the functioning organ; a vaso-constricting and a diuretic hormone formed in the posterior lobe of the pituitary body; a hormone controlling the growth of the bones and connective tissues produced in the anterior lobe of the pituitary body; a hormone controlling the oxidation of sugar in the body and produced in the cells of the islands of Langerhans in the pancreas; a hormone produced in the thymus which controls possibly in some way the development of the reproductive organs; a vaso-constricting hormone formed in the kidneys; a hormone in the salivary glands which controls the flow of water from the blood capillaries in the glands; a hormone produced in the fœtus in utero which stimulates the growth of the mammary glands; a hormone in the ovary which controls the growth of the uterus and the processes of menstruation; a hormone in the ovary which controls the implantation of the fertilized ovum and the growth of placental tissue; a hormone in the testis which initiates the development of the secondary sexual characteristics in the male; hormones of an indefinite number, produced in all the tissues and acting specifically upon the determinants in the gametes in such a way as to make possible the transmission of acquired characteristics. It is evident from this summary that there is a well developed tendency in physiology at the present day to utilize the conception of hormones to explain all relationships not otherwise intelligible. A few years ago the number of hypothetical enzymes in the body was likely to be increased whenever a new research in metabolism appeared, now the drift seems to be in the direction of manufacturing new hormones. This natural inclination to abuse a new and attractive idea will not of course prejudice us against the great importance of the suggestion which we owe to Bayliss and Starling. It is to be hoped only that no one will be tempted to give to these hypothetical hormones distinctive names, except in cases such as the secretin, adrenalin, etc., in which the substances have been isolated in some degree of purity. For once a specific name has become attached to an entirely unknown substance it acquires henceforth an easy currency in our literature, and soon many of us unconsciously assume that the thing so designated constitutes one of the verified facts of our science. By way of example one may cite the thrombokinase which has become such a familiar term in the literature of coagulation and which not infrequently is employed by writers as though its existence were a settled fact.

Among his other valuable suggestions regarding the characteristics of the hormones, Starling has called attention to the fact that some of them act by increasing the processes of disassimilation or catabolism, while others apparently stimulate the processes of assimilation or growth. In this latter group we may include the hormones of the anterior lobe of the pituitary body, according to the present conception of the functions of that gland, and all of the hormones of the reproductive cells. These latter have in general what has been designated as a dynamogenic action, they cause hypertrophies in various organs or tissues and invoke therefore processes of

synthesis rather than those of splitting and oxidation. Hypertrophy as an outcome of increased functional activity is a familiar phenomenon, but as Nussbaum remarks the hypertrophy induced by testicular or ovarian hormones resembles rather the effect of the growth energy exhibited by the developing embryo, in that it is dependent upon influences other than those arising from functional use. What these influences may be is at present a matter of pure speculation. In his recent most interesting contributions to our knowledge of growth Rubner has been led to assume that the property of growth in the young organism is connected with certain special chemical complexes in the protoplasmic material, complexes which have nothing directly to do with the simple maintenance of the nutrition of the cell and which after adult life is reached disappear for the most part from the general soma. In line with this hypothesis one might assume that the hormones given to the blood by the reproductive cells contain such complexes which when anchored in certain tissues lead to an accelerated growth. Perhaps the clearest and most interesting experiments made upon the reproductive hormones are those reported by Nussbaum. He chose for his experiments the males of *Rana fusca* whose reproductive organs go through a cyclical development each year. At the proper period the preparation for the mating season shows itself in the hypertrophy of the seminal vesicles, of the thumb pads and of certain muscles in the forearm. If the frog is castrated these hypertrophies do not occur, or if they have begun before the castration is performed retrogressive changes take place. On the other hand, the usual hypertrophy of the nuptial organs can be initiated in a castrated frog if pieces of the testis from another frog are introduced into the dorsal lymph sacs. The pieces thus introduced do not become grafted permanently but are gradually absorbed and the growth of the thumb pads and of the muscles in the forearms falls off after this absorption is completed. Nussbaum believes that the stimulating effect of the testicular hormones is not exerted directly upon the tissues which show the increased growth, but rather upon the portions of the central nervous system which innervate these tissues. This belief rests upon the experimental fact that if the peripheral nerves going to the glands and papillæ of the thumb pads are severed on one side the testicular hormone affects only the other intact side. This experiment and the conclusion drawn from it opens up the interesting question whether perhaps the reproductive hormones in general exert their effect through the central nervous system. This has not been the usual belief, and the experiments of Nussbaum are open to the obvious objection that the section of the peripheral nerves may have induced certain secondary changes in metabolism which indirectly antagonized the action of the testicular hormone. At present these experiments, so far as I know, have not been repeated with this objection in mind and it is somewhat gratuitous to criticize the author's conclusions until further work is reported.

William H. Howell
The Johns Hopkins University

SIR WILLIAM CROOKES[1]

The generation just passing away and that now enjoying the vigor of its beginning, are fortunate in this country, because they are recognizing the privileges and advantages of anniversary celebrations. The indulgence in

[1] Address of Professor Charles Baskerville before the Chemists' Club, Harvard Night, November 27, 1909, on which occasion Sir William Crookes was elected to honorary membership in the club.

such celebrations is not empty sentimentality, but possesses a practical value. They not only acquaint us with past events, but develop a true appreciation of their historical significance; and more than that, they stimulate within a finer realization of the actuating motive of sentiment, which is, after all, the basis of sympathy, the torch that leads one along dark passages and warms the heart to the best endeavors.

On December 10, 1859, appeared the initial number of Volume I. of the *Chemical News*. This journal, founded, owned and edited by William Crookes, is well known to English reading chemists the world over. However, some of the circumstances of its founding and subsequent development may not be known to all present. I shall, therefore, venture to direct attention to one or two important events in its history. In 1843, William Francis and Henry Croft founded the "*Chemical Gazette*, or Journal of Practical Chemistry in all its applications to Pharmacy, Arts and Manufactures." This journal was conducted until 1859, when it was followed by the "*Chemical News;* with which is incorporated the *Chemical Gazette:* a Journal of Practical Chemistry in all its applications to Pharmacy, Arts and Manufactures." The last-mentioned journal was founded and edited by William Crookes. From Volume III., the title has been the *Chemical News and Journal of Physical Science*.

In introducing the *Chemical News* to the chemical public, it was stated in the first number that "the diffusion of facts which may tend to improve and augment our knowledge of the arts and sciences upon which most of the operations of civilized life are based, must be a pleasing task to those who hold in esteem the welfare of mankind. It is with this feeling that the *Chemical News* is introduced to the world." Further,

> ... There is no weekly journal in England which has for its aim the publication of those scientific processes and discoveries, the knowledge of which tends so greatly to increase our importance as a nation devoted to improvement, refinement and industrial excellence. It is therefore to supply this deficiency that the *Chemical News* is now launched into the stream of scientific literature.

Although he did not bind himself to an inflexible rule of action, the plan laid out by the editor was as follows:

> Each number will be divided into several sections, which will have a general but no individual connection with each other. We shall commence with scientific and analytical chemistry, under which head will be given the results of elaborate investigations in the laboratory, by those pioneers of our science who by their labours pave the way for the subjects treated of in our next department—technical chemistry. Here will be described the practical applications of the processes, formulæ or chemical agents, which the labors of the purely scientific chemist have placed at the disposal of the manufacturer. In the department of agricultural chemistry especial care will be taken to place before the agriculturalists of the United Kingdom all the most interesting and useful information to be derived from Home or Continental sources, or from the States of America.
>
> Pharmacy, toxicology, &c., next follow, and the medical profession will here find from time to time everything of interest relating to Pharmacy, Materia Medica and Toxicology. Discussions upon medical reform and jurisprudence will also be freely admitted into these columns.

It was also announced that "The proceedings of the various learned societies in which the readers may be supposed to take particular interest will be given," as well as notices of books, patents, etc., and chemical notices from foreign sources, scientific notes and queries, laboratory memoranda, and answers to correspondents.

As the knowledge of chemistry was extended and the publication of other chemical journals devoted to special subjects was begun, the *Chemical News* has found it advisable to alter its original plan considerably; for instance, after the *Journal of the Society of Chemical Industry* was founded in 1882, it no longer remained the sole record for those interested in chemical manufactures; and the founding of various English journals on medical and pharmaceutical subjects has rendered the omission of these branches necessary.

The board of trustees of the Chemists' Club, in recognition of the successful completion of

the one hundredth volume of the *Chemical News* at the end of next month, unanimously resolved to forward a suitably engrossed letter of congratulations to Sir William Crookes. The letter has been prepared and reads as follows:

The Chemists' Club of the City of New York extends to Sir William Crookes, of London, hearty congratulations upon the completion of the one hundredth volume of the *Chemical News*, which, under his direction, has been so successfully devoted for a half century to "the diffusion of facts which may tend to improve and augment our knowledge of the arts and sciences upon which most of the operations of civilized life are based," and its members wish for him not only many more years in fruitful service, but that they and other men of science may profit by further additions to his already long list of rich contributions to theoretical specialized and practical scientific knowledge.

Morris Loeb, *President*

Parker C. McIlhinney, *Secretary*

Furthermore, the trustees unanimously voted to recommend that the club elect Sir William Crookes to honorary membership, and I was designated to present the matter to the club at this meeting. I perform this duty, which is a privilege, with extreme pleasure, and regard myself fortunate in being able to close my term as a trustee in paying a graceful tribute to one so deserving of our admiration and esteem, and one whose personal friendship I have enjoyed for a number of years.

William Crookes was born in London on June 17, 1832, and studied chemistry and later assisted Hofmann at the Royal College of Chemistry. In 1854 he became superintendent of the meteorological department of the Radcliffe Observatory, Oxford, and in 1855, professor of chemistry at the Science College, Chester ("Chester Training College"). In 1859 Crookes founded the *Chemical News*, to which reference has already been made; and in 1871 he became editor of the *Quarterly Journal of Science*, having previously served as coeditor with James Samuelson from the founding of the journal in 1864.

Crookes has been a fellow of the Royal Society since 1863, and was knighted in 1897. In 1887 he succeeded Dr. Hugo Müller as president of the London Chemical Society, serving two years. Crookes was elected president of the British Association in 1898, and, previously, in 1886, he had served as chairman of the chemical section. He has also been president of the Institute of Electrical Engineers. He has received honorary degrees of doctor of science from Oxford, Dublin and Cape of Good Hope universities.

Crookes engaged in original research at an early age, his first paper "On the Seleno-Cyanides" being published in 1851. In 1861 he discovered the element thallium, and in subsequent years investigated its properties and compounds. In 1865 he discovered the process of separating gold and silver from their ores by sodium amalgamation. In 1872 he was led by his experiments in determining the atomic weight of thallium to consider the subject of repulsion resulting from radiation, and invented the radiometer, which he afterwards modified as the otheoscope. He was engaged at the same time in examining the physical phenomena of modern spiritualism, and having become convinced of the existence of force exerted by an intelligent, disembodied agency, he announced his conclusions in his "Researches in the Phenomena of Spiritualism" (1874). Later Crookes pursued a course of investigation in regard to the properties of matter in a vacuum, and published some of the results in his "Molecular Physics in High Vacua" (1879). He asserted that he had discovered a fourth state of matter, the ultragaseous protyle, in which he maintained that the molecules are not in contact as in a liquid or gas, but isolated. Crookes's method of producing extreme vacua rendered incandescent electric lighting a practical possibility.

In 1880, in recognition of his discoveries, the French Academy of Sciences gave Crookes a gold medal and a prize of 3,000 francs. In 1875 the Royal Society awarded a Royal Medal to Crookes, and the same society awarded him the coveted Davy Medal in 1888, and the Copley Medal—"the ancient olive crown of

the Royal Society," as it was termed by Davy—in 1904. Three times has he been the Bakerian lecturer of the Royal Society.

Crookes has published the following treatises: "On Thallium" (1863); "On the Manufacture of Beet Root Sugar in England and Ireland" (1870); "Select Methods in Chemical Analysis" (1871, 1886, 1888, 1895); "A Practical Handbook of Dyeing and Calico Printing" (1874, 1883); "Dyeing and Tissue Printing" (1882); "La Genese des Elements" (1887); "Die Genesis der Elemente" (1888); "Elements et meta-Elements" (1888); a translation of Rudolf von Wagner's "Die Chemische Technologie" (1872, 1881, 1892); and several other less important translations and editions of German and French works on chemical subjects.

The list of his scientific papers would be too long to present here, but it may be said that Sir William Crookes is an authority on the rare earths and rarer elements, and on spectroscopy and sanitary science.

His investigations on the rare earths have been chiefly on the phosphorescence spectra of yttrium, samarium (cathode-luminescence spectrum) and erbia (luminescence spectrum); on the absorption spectrum of didymium; and on the separation of these earths and their distribution (universal distribution of yttrium and scandium). In 1899, Crookes announced the existence of a new element, *victorium*, earlier called *monium*, and previously (in 1886) he claimed to have discovered two new elements, *ionium* and *incognitum*. In 1876, Crookes devised the well-known "Crookes Tube," and in 1903 the spinthariscope. His investigations of the radio-active elements have also been noteworthy, and in 1900 he fractioned uranium nitrate into an inactive product, thereby obtaining an active substance, Ur-X.

In sanitary science, the important work of Crookes has been on sewage disposal, on water supply and contamination, on the use of disinfectants, and on the wheat problem.

Crookes has delivered the following addresses: "On Radiant Matter" (British Association, Sheffield Meeting, August 22, 1879); "On Radiant Matter Spectroscopy" (Bakerian Lecture, Royal Society, May 31, 1883); address to the chemical section of the British Association, Birmingham Meeting, September 2, 1886, dealing with the nature and origin of the so-called elements; "Genesis of the Elements" (Royal Institution, February 18, 1887); address as president of the Chemical Society, anniversary meeting, March 28, 1888; "On Recent Researches on the Rare Earths" (annual general meeting of the Chemical Society, March 21, 1889); "Diamonds" (Royal Institution, June 11, 1897); British Association Inaugural address, Bristol, 1898, dealing mainly with the "Wheat Problem"; and his admirable lecture on "Diamonds" before the British Association, Kimberley meeting, September 5, 1905.

Sunday evenings, Sir William is at home. Within his study walls, bebooked to the ceiling, one may find then the finest minds of science in England or other lands, grappling in discussion with the unsolved problems, which oftentimes become no clearer than the increasing denseness of the tobacco smoke. Promptly at eleven o'clock there comes a bright rift in the clouds as Lady Crookes enters and charmingly leads all to the dining room below.

Punctilious in the performance of every duty, courteous but vigorous in argument, modestly assertive, learning from the youngest, Sir William draws out the humblest until he would become almost bold, yet, in return, he gives generously from his rich store of wide knowledge and large experience. Such is the man the trustees would have the club honor and thus gain luster itself, for William Crookes, the *savant*, ornaments any company, and his life work is an inspiration for the present generation and the generations of men of science to come.

THE INTERNATIONAL AMERICAN CONGRESS OF MEDICINE AND HYGIENE

THE International American Congress of Medicine and Hygiene of 1910 in commemoration of the first centenary of the May revolution of 1810, under the patronage of his excellency, the President of the Argentine Republic,

will be held May 25 in Buenos Aires, Argentine Republic.

In order to facilitate the contribution of papers and exhibits from the United States, there has been appointed by the president of the congress, Dr. Eliseo Cantôn, and the Minister of the Argentine Republic at Washington, a committee of propaganda of which Dr. Charles H. Frazier (Philadelphia, Pa.) is chairman and Dr. Alfred Reginald Allen (Philadelphia, Pa.) is secretary.

The congress has been divided into nine sections, each section being represented in the United States by its chairman in this committee of propaganda as follows:

Section 1—Biological and Fundamental Matters, Dr. W. H. Howell, Baltimore, Md.

Section 2—Medicine and its Clinics, Dr. George Dock, New Orleans, La.

Section 3—Surgery and its Clinics, Dr. John M. T. Finney, Baltimore, Md.

Section 4—Public Hygiene, Dr. Alexander C. Abbott, Philadelphia, Pa.

Section 5—Pharmacy and Chemistry, Dr. David L. Edsall, Philadelphia, Pa.

Section 6—Sanitary Technology, Dr. W. P. Mason, Troy, New York.

Section 7—Veterinary Police, Dr. Samuel H. Gilliland, Marietta, Pa.

Section 8—Dental Pathology, Dr. George V. I. Brown, Milwaukee, Wis.

Section 9—Exhibition of Hygiene, Dr. Alexander C. Abbott, Philadelphia, Pa.

It will not be necessary for one contributing a paper or exhibit to the congress to be present in person. Arrangements will be made to have contributions suitably presented in the absence of the author. The official languages of the congress will be Spanish and English. Papers may be sent direct to the chairman of the particular section for which they are intended, or to Dr. Alfred Reginald Allen, secretary, 111 South 21st Street, Philadelphia, Pa.

SCIENTIFIC NOTES AND NEWS

PRESIDENT TAFT has appointed Professor Henry S. Graves, director of the Yale Forestry School, as forester of the U. S. Forest Service to succeed Mr. Gifford Pinchot. He has also appointed Albert F. Potter, at present acting forester, as associate forester.

M. EMILE PICARD has been elected president of the Paris Academy of Sciences for 1910. He is succeeded by M. Armand Gautier as vice-president.

THE Paris Academy of Sciences has awarded the Pontécoulant prize to Professor E. W. Brown for his work on the motion of the moon.

SIR JAMES DEWAR, F.R.S., has been elected a foreign member of the Reale Accademia dei Lincei, of Rome.

PROFESSOR THOMAS DWIGHT, of Harvard University, was made an honorary member of the Anatomical Society of Great Britain and Ireland at the last annual meeting.

COLONEL CHARLES CHAILLE-LONG, the well-known American explorer, who served as chief of staff to General Gordon in the Sudan, has been awarded the gold medal of the American Geographical Society for his services to geographical science in Africa.

THE Chemical Society, of London, in view of the completion of fifty years' fellowship by the past presidents, Sir Henry Roscoe, Sir William Crookes, Dr. Hugo Müller and Dr. A. Vernon Harcourt, will entertain these fellows as guests of the society at a dinner to be held some time at the end of May or the beginning of June.

AT the annual election of the American Philosophical Society held on January 7 the following officers were elected for the ensuing year: *President,* William W. Keen; *Vice-presidents,* William B. Scott, Albert A. Michelson, Edward C. Pickering; *Secretaries,* I. Minis Hays, Arthur W. Goodspeed, James W. Holland, Amos P. Brown; *Curators,* Charles L. Doolittle, William P. Wilson, Leslie W. Miller; *Treasurer,* Henry La Barre Jayne; *Councillors* (to serve for three years), Edward L. Nichols, Samuel Dickson, Ernest W. Brown, Morris Jastrow, Jr.

THE American Phytopathological Society elected the following officers for 1910 at its recent Boston meeting: *President,* Dr. F. L. Stevens, North Carolina Agricultural and

Mechanical College; *Vice-president,* Professor A. F. Woods, U. S. Department of Agriculture; *Secretary-Treasurer,* Dr. C. L. Shear, U. S. Department Agriculture; *Councillors,* Dr. L. R. Jones, University of Vermont, Professor A. D. Selby, Ohio Agricultural Experiment Station, and Professor H. H. Whetzel, Cornell University.

OWING to friction with some of the trustees, Professor E. Dwight Sanderson has been compelled to retire from the directorship of the Agricultural Experiment Station of the New Hampshire College.

DR. V. M. SPALDING, having retired from the staff of the Desert Laboratory, has removed from Tucson, Arizona, to Loma Linda, California, which will be his address for the present.

MAYOR GAYNOR has announced the appointment of Dr. Ernst J. Lederle as health commissioner of New York City to succeed Dr. Darlington. Dr. Lederle was health commissioner during the term of Mayor Low.

THE British Local Government Board has appointed Dr. Eastwood, one of the pathologists of the royal commission on tuberculosis, an additional medical inspector of the board, with a special view to his undertaking pathological investigations. Provision also has been made for the necessary assistance and laboratories. The immediate object will be to apply to public health work the results obtained by the royal commission on tuberculosis, and to ensure the freedom of important foods from infection.

WE learn from *Nature* that the following appointments have been made to the Indian Agricultural Service: Imperial agricultural bacteriologist, Mr. C. M. Hutchinson; supernumerary mycologist, Mr. F. J. F. Shaw; supernumerary agriculturist, Mr. G. R. Hilson. The two posts of assistant superintendent recently vacant in the natural history section of the Indian Museum, Calcutta, have been filled by the selection of Mr. Stanley W. Kemp and Mr. F. H. Gravely.

THE Swiss government will send a scientific expedition into the unexplored parts of Bolivia under the leadership of Professor O. Fuhrmann, of the University of Neuchâtel.

DR. G. C. BOURNE, M.A., D.Sc., Linacre professor of comparative anatomy, Oxford, delivered the Herbert Spencer Lecture at Oxford University on December 2. His subject was "Herbert Spencer and Animal Evolution."

A MONUMENT is to be erected to the memory of Laplace at Beaumont, in Auge (Calvados), where he was born in 1746.

THE Joseph Eichberg chair of physiology in the Ohio-Miami Medical College of the University of Cincinnati was formally established on December 11, at a meeting of the trustees of the Academy of Medicine. An endowment of $45,000 was raised for this chair by the academy and a few friends of the late Dr. Eichberg.

DR. LOUIS KRAUTER, assistant professor of botany in the University of Pennsylvania, and Mr. E. J. W. Macfarlane, son of Professor John M. Macfarlane, professor of botany in the university, were frozen to death when hunting near Wildwood, N. J.

DR. SHELFORD BIDWELL, F.R.S., known for his researches in electricity and optics, died on December 18, at the age of seventy-one years.

SIR EDWARD L. WILLIAMS, the British engineer, designer of the Manchester ship canal, died on January 1, at the age of eighty-one years.

M. BOUQUET DE LA GRYE, the eminent French hydrographic engineer and astronomer, has died at the age of eighty-two years.

PROFESSOR LORTET, honorary dean of the medical faculty in the University of Lyons, known for his work in archeology, has died at the age of seventy-three years.

DR. LUDWIG MOND, the eminent industrial chemist, has bequeathed £50,000 to the Royal Society and the same amount to the University of Heidelberg for the endowment of research in natural science, more particularly in chemistry and physics. The bequests take effect on the death of Mrs. Mond.

The estate of the late Dr. Thomas W. Evans has been settled after tedious litigation, and it is said that about $6,000,000 is now available for a museum and dental college in Philadelphia.

The annual message of Governor Hughes, of New York, announces the gift by Mrs. Harriman, in accordance with the plans of the late E. H. Harriman, of 10,000 acres of land and a million dollars for a state park in the Highlands on the west side of the river. Gifts for this purpose are also announced, amounting to $1,625,000 from Mr. J. Pierpont Morgan, Mr. John D. Rockefeller and others. These gifts are conditional on the sum of $2,500,000 being appropriated by the state, and are subject to certain other reservations.

Through the bequest of Miss Phœbe Anna Thorne, the American Museum of Natural History receives ten thousand dollars for its permanent endowment. The income of the fund is to be used in such a manner as to perpetuate the memory of her father.

The United States Pharmacopeal Convention will be held in Washington on May 10, 1910, for the first time as a corporate body. The chairman of the committee on credentials and arrangements is D. Oliver T. Osborne, of New Haven, Conn., and the secretary is Dr. Murray Galt Motter, 1841 Summit Place, N. W., Washington, D. C.

A joint committee of the Mathematical Association, London, and the Association of Public School Science Masters have been considering the possibility of correlating the teaching of mathematics and science, and have prepared a report on the subject. A joint meeting of the two associations was held at Westminster School on January 12, under the chairmanship of Professor Forsyth, F.R.S., to consider the report.

The fifth International Ornithological Congress will be held in Berlin May 30 to June 4, 1910, under the presidency of Dr. Anton Reichenow. The Congress will be organized in six sections: I., Anatomy and Paleontology; II., Systematic Ornithology and Geographical Distribution; III., Biology and Oology; IV., Bird Protection; V., Introduction and Acclimatization; VI., Aviculture.

The *Auk* states that in the alterations and additions to the Academy of Natural Sciences at Philadelphia that have just been completed, the ornithological department has been allotted half of the top floor of the main museum building, directly over the exhibition bird gallery. There is an abundance of light in the new quarters and the collection of skins is arranged to better advantage than ever before. The specimens, numbering upwards of 50,000, are arranged in 200 metal cases carrying trays 16×18 inches, and 50 large cases with trays 3×6 feet, while at the west end is a spacious work room and meeting room where the Delaware Valley Ornithological Club now holds its sessions. The exhibition series of mounted birds numbers about 10,000, besides which is a large collection of osteological material, nests and eggs.

The British government has promised £20,000 for the Antarctic expedition under Captain Scott, and about £12,000 has been subscribed from other sources. Reuter's agency states that progress is being made with the preparations. Dr. Wilson, chief of the scientific staff, will also be the zoologist and artist. It is anticipated that three geologists will accompany the expedition, and that one of these will be Mr. Mackintosh Bell, director of the Geological Survey of New Zealand, who has volunteered his services. Mr. R. Simpson, of the Indian Survey Department, will be the physicist. He is now on his way to England from Simla. A second physicist will be taken. There will be two, or possibly three, biologists. With Dr. Wilson will be associated a second medical man, who will study botany and bacteriology, giving particular attention to the investigation of blood parasites. The services of Mr. C. R. Meares, who lately completed a journey on the Chino-Tibetan border, have also been secured. He will leave England almost at once for eastern Siberia to obtain the ponies and dogs. He will collect the animals at Vladivostock, from

which place they will be sent to Kobe and trans-shipped from Australia and New Zealand. Mr. Meares will join the expedition in New Zealand.

The third paper dealing with the results of the Smithsonian African Expedition under Mr. Roosevelt has been issued by the Smithsonian Institution as No. 1883 of the Miscellaneous Collections. It describes a new species of otocyon to which the specific name of *virgatus* is given. The animal is a small carnivorous mammal closely resembling a fox. It is generally buff in color and it has been found by Mr. Gerrit Miller, of the museum staff, to differ slightly from *Otocyon megalotis*, which occurs farther south, especially in color and in the characteristics of its teeth and skull. The otocyon is peculiar to Africa and is not represented in the United States, but resembles in color the swift or kit fox of the western plains. The skull of this new form closely resembles that of the gray fox of our native fauna.

The *Experiment Station Record*, quoting from *Conservation*, states that the Biltmore Forest School, Biltmore, N. C., closed on November 1, when Dr. C. A. Schenck, who had been superintendent of the school for about fifteen years, severed his relations with the Biltmore estate. Some twenty-five of his students have signified their intention of continuing their work under his direction and will accompany him to Germany. A new school under his management is to be organized, to retain the name of the Biltmore Forest School, but instead of having a single fixed location it will carry on work over a wide range of forests. The principal headquarters will be in Germany near the Black Forest, where the school will be located for about six months each year. For the rest of the year practical work in the forests of Maine, Wisconsin and eastern Tennessee is contemplated.

The *Journal* of the American Museum of Natural History states that the department of anthropology has recently been enriched by the accession of two large local collections. The first of these was made on Manhattan Island by Messrs. Calver and Bolton. It is particularly valuable, because the sites on the upper end of the island, whence the objects were obtained, are fast becoming obliterated. Several skeletons are particularly interesting as being the only authentic remains of the Manhattan aborigines known. There is also a large and perfect pottery vessel of the Iroquoian type from the upper end of Manhattan Island. The second collection was made on Staten Island during the years 1900–9 by Mr. Alanson Skinner, of the department of anthropology, and is the largest and most complete in existence from this locality, consisting of nearly 1,200 specimens.

Statements made to the United States Geological Survey by operators and others conversant with the coal mining industry indicate that the production of coal in the United States in 1909, while exceeding that of 1908, did not reach the high-water mark attained in 1907, the banner year of industrial activity in this country. It is, of course, impossible to give accurate information regarding tonnage, but it appears from the reports received from the coal-mining states by Edward W. Parker, statistician of the survey, that the increase in production in 1909 over 1908 was between 8 and 10 per cent., which would indicate a total production of from 440,000,000 to 450,000,000 short tons. Exclusive of the output from Sullivan County, the shipments of anthracite from the mines in Pennsylvania during the eleven months ended November 30, 1909, amounted to 56,194,447 long tons, against 58,837,076 long tons for the same period in 1908. It is estimated that the shipments in December will amount to 5,500,000 long tons. To the shipments should be added the usual percentage for local trade and colliery consumption and the production of Sullivan County, which would bring the total production of Pennsylvania anthracite in 1909 to approximately 71,150,000 long tons, or about 79,700,000 short tons, and the bituminous production will have amounted to between 360,000,000 and 370,000,000 short tons. The largest production from the anthracite

mines of Pennsylvania in 1908 was caused by a stimulated activity due to an apprehension of a suspension on April 1, 1909, when the wage agreements would terminate. This activity continued through the first three months of 1909, and the shipments in March, 1909, were the largest in the history of the trade. With the renewal of the wage scale in April, which was in fact a continuance of the awards of the anthracite strike commission for a third period of three years, production fell off, and the shipments of the summer months of 1909 were much less than in either 1907 or 1908.

THE Department of Superintendence of the National Educational Association will meet at Indianapolis on March 1, 2, 3 and 4. With the department will meet the societies for the Scientific Study of Education, the Society of College Teachers of Education, the Conference of State Superintendents of Education, the National Committee on Agricultural Education, the Educational Press Association of America, the American School Hygiene Association, the American Physical Education Association and the Public School Physical Training Society. The National Educational Association will hold its annual meeting this year either in San Francisco or in Boston.

THE opening of the International Scientific Congress to be held in Buenos Aires has been deferred from May 25, the original date, until July or August. The following Americans living in Argentina form a committee of the congress representing the United States: Professor Walter Gould Davis, chairman (chief of the Argentine Meteorological Service); Professor C. D. Perrine (head of the Córdoba Observatory); Professor R. H. Tucker (in charge of Carnegie Observatory, San Luis), and L. G. Schultz (chief of Magnetic and Solar Physics Division, Meteorological Service).

WE are requested by the director of the Treptow Astronomical Observatory to print the following note in the "redactionnal part" of SCIENCE: "Professor Dr. A. Korn will be so kind as to hold some mathematical lectures about: 'Freie und erzwungene Schwingungen, eine Einführung in die Theorie der linearen Integralgleichungen,' in favor of the Treptow-Sternwarte. The inquisitions about this theory take a first place in the mathematical inquiries of our time, and have given us already well-known results in new forms, as well as completely new ones. The lectures will take place in the new auditory of the Treptow-Sternwarte, from January 20 till March 20, 1910, on every Monday and Thursday from 6–7 hour. (One lecture is on Thursday, January 20, 1910.)"

UNIVERSITY AND EDUCATIONAL NEWS

MR. J. PIERPONT MORGAN has given $100,000 to Yale University, to establish a chair of Assyriology and Babylonian literature in memory of William M. Laffan, late editor of the New York *Sun*.

THE directors of George Washington University have announced that they propose to raise an endowment fund of $2,000,000. Mr. Henry C. Perkins, a member of the board, made an initial subscription of $50,000 toward the fund on condition that the sum be raised.

DR. CHARLES GRAHAM, formerly professor of chemical technology in University College, London, has left his residuary estate (estimated to be £35,000) to the college for research in the School of Advanced Medical Studies of the University of London.

THE new Carnegie Physics Laboratory, University College, Dundee, has been formally opened by Professor Sir Joseph J. Thomson, of Cambridge University.

DR. JOHN W. BAIRD, assistant professor of psychology at the University of Illinois, has been appointed professor of psychology at Clark University, to succeed Dr. Edmund C. Sanford, who has become president of Clark College.

MR. F. J. M. STRATTON has been appointed assistant to the professor of astrophysics in Cambridge University to succeed the late Mr. Cookson.

DR. J. L. SIMONSEN, assistant lecturer and demonstrator in chemistry in the University

of Manchester, has been appointed professor of chemistry in the University of Madras, and Dr. A. Holt has succeeded him at Manchester.

DISCUSSION AND CORRESPONDENCE

INTERNATIONAL LANGUAGE

THE history of artificial languages for international communications presents some of the same features as many other human inventions. At first people began to work out such languages from so different points of view that the first attempts are extremely unlike one another and have only that one point in common that they are just as impracticable as the first flying machines were. But gradually all phantastic elements were eliminated, and now we have reached a period where practically every one works on the same basis and where only small differences are found between the various systems proposed or practised by all serious believers in an international language. As Ostwald puts it, "the international language is no longer the matter of more or less noisy enthusiasts, but a serious and technical problem, which we are going to solve just as well as we are solving the flying problem."

The first "universal languages," such as those of Dalgarno (1661) and Wilkins (1668), were "philosophical" or *a priori* systems, in which each thing was denominated according to its place in a universal logical system. In one *bu* is mammal, *be* fish, *ba* insect, the various orders and suborders being denoted by added letters and syllables; but as there is no earthly reason why we might not just as well use *ub* and *eb* and *ab* or *mi, mo, mu,* no two such systems have one syllable in common. The next step is represented by such languages as Schleyer's Volapük, which is only semi-philosophic, most of the words being English roots, many of them, however, strangely disfigured to fit in with the requirements of the completely philosophical and arbitrary grammar: *vol* = world, *pük* = speech, *Melop* = America, because no word was allowed to contain an *r* or to begin or end with a vowel, as that would interfere with Schleyer's prefixes and suffixes.

An enormous step in advance was made in Dr. Zamenhof's Esperanto (1887), because in the majority of words he retained the forms that were already international. But unfortunately he still has too many Volapükisms in his language. Not only does he disfigure many of the words taken from actual languages, as when *alert* becomes *lerta* (with an arbitrarily changed signification, too) or when French *aboyer* becomes *boji;* but he also quite arbitrarily coins some words with no foundation whatever in any language. As these are among the most frequently used in the language (pronouns, etc.) they give an air of strangeness and unfamiliarity to nearly every Esperanto sentence and probably more than anything else have deterred a great many people from taking the trouble to learn the language.

Since 1887, many people have worked out closely related artificial languages which all tend to keep the good features of Esperanto and to eliminate the bad ones. When the scientific committee elected by the Delegation for the Adoption of an International Auxiliary Language set to work in 1907, it found in the works of Liptay, Beerman, Molenaar, Peano and others, but above all in those of the "Academy" that had created the *Idiom Neutral,* a wealth of valuable suggestions all tending practically in the same direction, namely, in the direction of those elements of Esperanto which had never been criticized. On the other hand, it found an almost unanimous criticism of much in Esperanto not only on the part of believers in the possibility of an international language, but also on the part of such skeptics as the famous Leipzig philologists, Brugmann and Leskien; the points criticized in Esperanto were in all cases practically the same, namely, those in which Zamenhof had arbitrarily created something instead of finding out what was already the most international expression.

The language resulting from a careful investigation of all previous attempts is Ido: it must appeal to all unbiased minds because it is nothing but a systematic turning to account of everything that is already international,

that root being chosen in each case which will be most readily understood by the greatest number of civilized people. A few examples will show the contrast between Esperanto (given first) and Ido; I add the English translation:

bedauri—regretar, "regret";
chiu—omnu, "everybody";
eco—qualeso, "quality";
elparoli—pronuncar, "pronounce";
malsupreniri—decensar, "descend";
farto—stando, "state of health";
ghojo—joyo, "joy";
kial—pro quo, "why";
kiom—quanto, "how much";
neniam—nultempe, "never";
nepre—absolute, "absolutely";
parkere—memore, "by heart";
tago—jorno, "day";
vosto—kaudo, "tail."

Now, what has been the attitude of the Esperantists towards this new language? I am happy to say that a great many of them have frankly acknowledged its merits and are now active propagandists for it. If one looks through articles published before 1907 and sees the names there praised as those of the best Esperantists, one recognizes many of those who are now ardent Idists (Schneeberger, de Beaufront, Kofman, Lemaire, Ahlberg, Grillon). Among four Americans who were elected members of the Esperantist *Lingva Komitato,* three are now Idists. But on the other hand a great many Esperantists have stuck to the old language and tried to kill Ido, first by a conspiracy of silence and then by a misrepresentation of facts and of persons connected with the whole affair. And a great many people seem to take everything told in the Esperanto papers as truth instead of acquiring a first-hand knowledge of the new language. Two letters in SCIENCE of December 10 seem to call for an answer, as they are rather more fair than many articles in Esperanto periodicals. And I am thus obliged, against my usual practise, to say something about personal matters that have very little bearing on the real question at issue: it is not the persons supporting or deserting a language, but the essential features of the language that are of real importance in the long run.

Ever since the first appearance of the new language it has been the tactics of the Esperantists, not to examine the language itself, but to discredit it by relating how now this, now that member of the Delegation Committee had "resigned from it in disgust." Thus I read at one time in the *Amerika Esperantisto,* that Professors Jespersen and Ostwald had left the committee; this piece of news made a profound impression on me, though I must add that I know from the very best sources that it was not true. Now I read in SCIENCE that Professor Dr. Adolph Schmidt also is one of those members who left the committee. Unfortunately, I do not know just how deep my regret should be, as I have not the slightest idea who that gentleman is; the only thing I know with certainty is that he was not elected a member of said committee and was not present at a single one of its meetings, all of which I attended from beginning to end.

Only one member ever left our committee, and that was Professor Foerster, of Berlin, who saw fit to resign—exactly one year after the committee had finished its work and printed its official report. I fail to see the significance of his act of resignation at that moment, but it constitutes the only fact of what Mr. Spillman calls the disruption of the International Language Committee.

Mr. Spillman goes on to say that "these gentlemen are not at all agreed as to the structure of their language." It is a usual thing for Esperanto papers to say that we change our language about once a month. Now, I defy any one to find any difference between the first specimen ever printed in Ido and the language used in the very last issues of *Progreso* or *Belga Sonorilo,* etc. But the former periodical has invited criticism of Ido in a thoroughly open-minded and scientific spirit and has printed articles by authors experimenting with other "dialects"; but that of course does not change the language any more than Danish is changed by the admission in a Danish periodical of articles written in the closely related Norwegian and Swedish lan-

guages. I quote from the latest number (December, 1909) of *Progreso* a few lines which the readers of SCIENCE will be able to make out for themselves if I explain that *Fundamentists* are the orthodox Esperantists who look upon Zamenhof's *Fundamento* as a holy book of which not one jot or one tittle must ever be altered:

La Fundamentisti, por salvar la lingual uneso [unity], supresas omna [all] libereso; ni [we] ne devas imitar li; ni devas, ne nur [only] tolerar, sed admisar la kritiko, nam [for] se ni ne admisus ol [it] inter ni, sub formo di amikal e bonvola diskutado, ol eventus exter ni, e konseque kontre ni; nulu povas [no one can] supresar, sufokar la kritiko; la max grava eroro e kulpo di l'Esperantista chefi esis, ke li malsaje [unwisely] volis exterminar ol ek lia armeo. Segun la paroli di So. Sterrett, la kritiko ne esas la morto, sed la vivo di ciencala entraprezo quale la nia [ours].

Thus on all points we substitute scientific methods and procedures for haphazard and arbitrary word-coinages and a blind swearing in the words of the "majstro" Zamenhof.

Just as some people have two religions, one for Sundays and another for week days, Esperanto has two spellings. One is the real thing with five circumflexed consonants; if you hand in a telegram in that orthography, it can not be correctly transmitted, and most printing offices can not print texts thus written; typewriters have to be specially equipped for these letters, and in ordinary writing they are cumbersome because the pen has to be lifted very frequently from the paper. No other system of artificial language has anything like these letters, which are thus shown to be unnecessary. Zamenhof himself in 1894 recognized these circumflexed letters as a "very important hindrance to the spreading" of Esperanto, but still he opposes any attempt to discard them and only allows his followers to use an *h* after the letter as a permissible spelling whenever the real Esperanto letters can not be had. This leads to such spellings as *hhemio*, which few chemists will gladly accept as the name of their science, and even in extreme cases to four successive *h*'s (monahhhhoro!). Therefore some Esperantists have tried other desperate remedies, writing *s'ang'o* or *sângô* instead of *sango* with circumflex over *s* and *g*, or *shangho* (Ido, *chanjo*). Whichever way you spell Esperanto, it looks unsightly, and in many cases unnecessarily alters the aspect of international words.

Mr. Kellerman finds that Ido is less musical and more monotonous than Esperanto; I have not yet found any one who was of the same opinion after listening to one half page of the same text translated into both languages, as the numerous *aj-oj-ujs* and the frequent sibilants of Esperanto are avoided in Ido. Mr. Kellerman also speaks of the "harsh Anglo-Saxon pronunciation of the letter *j*" in Ido. He will allow a phonetician to say that it is neither harsh nor Anglo-Saxon; besides, is Ido *joyo* harsher than Esperanto *gojo* with a circumflex over *g* or *ghojo?* The sound is identical in both cases, but Esperanto spells the initial sound in two ways unexampled in any language, living or dead, while Ido here as elsewhere selects the most international form.

The only refutation of Mr. Kellerman's assertion that Esperanto is more logical and more truly international than Ido and that Ido lacks definite rules is by a comparison of the two systems: I hope many of the readers of SCIENCE will undertake that comparison for themselves by a study of our grammars and readers or of parallel texts in both languages. Such an examination will soon make them see where the truth of the matter lies.

The main consideration with Mr. Kellerman seems, however, to be the number of adherents, and I must admit that Esperantists still are more numerous than Idists. But, as the boy said when applying for some work and being met with the objection that he was too young: "I shall improve in that respect every day." Ido certainly gained more followers in the first twelve months of its existence than Esperanto did in the first twelve years of its life. Mr. Kellerman quotes from the title page of the *Internacia Scienca Revuo* seventeen names of noted men of science who support that periodical. There is no doubt that *Scienca Revuo* would be a more valuable paper if these men also appeared inside the cover,

but as a matter of fact the great majority of them never published anything in Esperanto. Their support is purely platonic, and as it was given before the birth of Ido, it shows their approval of the general idea of an international language more than of that particular form of such a language. It is a significant fact that not a single philologist has accepted Esperanto in its Zamenhofian shape; the only one mentioned in Esperanto papers is Baudouin de Courtenay in St. Petersburg, but he has publicly declared that "Of course, Esperanto needs improvements," and though he does not accept Ido in every detail, he says that it is better than Esperanto in many respects. But the leading French Esperanto paper (*Lingvo Internacia*) refused to print a protest from Baudouin de Courtenay after they had printed what purported to be an article by him entirely in favor of Esperanto, which he had never written.

I am optimist enough to believe that the present tactics of many Esperantists will soon cease, and that they will then see that a good cause can only be furthered by a loyal discussion of the pros and cons without regard to persons. No great invention, no great scientific discovery, ever sprang into the world full-fledged; they all have required the patient cooperation of many minds. Yet we are to believe that Dr. Zamenhof's invention of 1887 stands in no need of improvement in its vital elements; and it is considered a sacrilege to whisper that its alphabet is cumbersome, many of its roots badly selected, much of its grammar too capricious and its methods of word-formation insufficient and amateurish, and that by setting to work on scientific principles it is possible to devise a much better language of a much more truly international character, "not perfect," perhaps, "but always perfectible."

OTTO JESPERSEN
COLUMBIA UNIVERSITY

SCIENTISTS AND ESPERANTO

IN SCIENCE for December 3 appears an interesting note on Esperanto from the pen of Professor Tingle, in which he criticizes the statement made in a former article of my own, that the adoption of an international language is the solution of many difficulties for scientific men. Waiving the fact that he applies the quotation he makes in a manner other than the context will strictly warrant, his remarks still leave unshaken my conviction that the use of the international language would be a means of lightening the linguistic burdens of all scientific workers, and among them, of the chemists; even under the somewhat drastic conditions of the hypothetical case he cites.

I venture to believe, that if, as he supposes, subsequent to January 1, 1910, all chemical communications were compelled to be made in Esperanto, the result would not be, as he fears, simply the additional burden of another language to be learned, but that, on the contrary, chemists would discover that they did not need to be also expert linguists in order to keep in touch with the movements of their science throughout the world, and that, while possibly a *reading* knowledge of certain modern national tongues, for perusal of matter already chronicled, was still desirable, a *speaking and writing* knowledge, a very different matter, had become, almost, if not entirely, unnecessary in their scientific work. Such an intimate knowledge would be needed of one language only and that, the simplest of all, Esperanto. The authors of the communications would also find a much larger audience, to the advantage both of themselves and of the world in general.

It is true that sometimes, in quoting from existing writings, it is desirable to use the language in which the author wrote, in order to clearly express his thought, and to this extent would it be necessary to permit the use of other tongues than the international one, but this would be a very small item compared with the immense gain that all the new facts and theories of the science would be expressed in the world language, and, as the years rolled by, the necessity of using any national language in such international communications and contributions would grow less and less—to finally disappear.

Even the *reading* knowledge of natural tongues required for study or reference would be immediately reduced to a minimum, because large amounts of matter which at present are not translated into the national languages, for no other reason than that the demand for it in each tongue will not justify the expense, could be translated into the accepted international idiom, as it would then have the world for a market. Every year this minimum would steadily approach zero, as new theories and methods superseded old and were given to the world by their authors, in Esperanto.

The desirability of having an author's own words and expressions, whether one is studying him privately or quoting from his works, is only another reason why that author, when desiring to reach all the world, should write in a common tongue, which all the world can easily understand, and the acquisition of which, to those chemists or other scientists of the present day who already know English, French and German, is but child's play. Such should be willing to accept this "burden" (?), in order that their less gifted brethren may have also the advantages of reading in the original, scientific matter to be hereafter recorded.

We can not change the writings of the past, but the book of the future is ours to make or mar, and how better can we fill its pages than by recording the new triumphs of science in *one* language, an international language, which even her humblest worshipper may readily acquire? J. D. HAILMAN

PITTSBURGH,
December 13, 1909

RELATIVITY AND SOME OF ITS CONSEQUENCES

THE discussion of relativity in the recent meeting of the American Physical Society in Boston was a serious disappointment to me. It interfered with some of my future plans, and it left me in the dark concerning how those plans might be amended.

I had intended, when I became a disembodied spirit, to start outwards from my space locus at that instant, and to travel with twice the velocity of light along my individual time emanations, until I had reached the beginning of my time career. I was, and am, curious to see how that history would appear when reviewed backwards in this manner. I had then planned to pause until my history should overtake me again. This would give me a chance to see myself as others had seen me. I had previously realized that this would be a cruise which would require a great deal of skill by reason of the constantly changing position of my individual time and space locus, due to terrestrial and solar motion. Still I had thought it possible to follow the tangled trail, by keeping my course at right angles to the daily and annual wave fronts, as they successively presented themselves.

It had seemed possible also to gain in this manner the experimental data necessary in the framing of a general system of vector analysis. This system would enable one to start with the space locus at which the earthly clay was shaken off, and to locate with reference to it any other point in his own time and space career. An increase in the length of the space vector in any direction would simultaneously carry one outward in space, forward in time and backward in history.

The Boston discussion did not supply one item of information which I had confidently expected. It is necessary that one should, on such a cruise, know the precise number of cubic miles in a cubic year. This information was not given us. In addition it was revealed that it is not possible for any velocity to be greater than that of light, or 3×10^{10} cm. per second.

Is this conclusion final? We can see that the waves which contain our spoken words lag greatly on those which embody our visible acts. May there not be some more refined medium, a spiritual medium, perhaps, in which v can exceed 3×10^{10} cm. per second?

Evidently we must no longer sneeze at discussions concerning the relation between the whereness of the when and the whenness of the where. The equations placed on that

Boston blackboard show that it may become possible to determine the relation between the present space locus of the instant when John Hancock finished his signature to a certain immortal document, and the present time locus of the point in space which his center of gravity then occupied.

FRANCIS E. NIPHER

"GEOMETRICAL" CANALS ON MARS? A SUGGESTION

At the present writing, Mars is traveling rapidly away from the earth, but, unfortunately, its mystery remains. Much was expected from the observations to be made at the recent opposition, the most favorable one in some respects since 1892; and the planet has in fact been studied eagerly and carefully with telescopes of many sizes and kinds, and all the resources made available by the advance in our knowledge of photographic and spectroscopic processes have been drawn upon to aid in solving the problems Mars presents. The details of these observations, for the most part, have not yet been published, but enough has been written to show that the average astronomer, as well as the intelligent layman, is left in as great doubt as to the actual configuration of the surface of Mars and the meteorological conditions prevailing there as he was a year ago.

Even the fundamental question as to the size of telescope best adapted to the study of planetary detail remains an open one. On the one hand, an expert areographer, owner of a 24-inch refractor, has repeatedly claimed for his telescope "greater space-penetrating powers" (due to the combined excellences of his lens and his atmosphere) than those possessed by any other in the world, and says that it is by virtue of these powers that he can see Martian details invisible elsewhere. On the other hand, an astronomer in charge of a much larger refractor has recently said that his telescope was *too powerful*[1] to show the canals on Mars. Again we are told that to get the best results in such studies we must use comparatively small telescopes or "cap down" the object glasses of the larger instruments—even a 24-inch aperture is improved by this process, it is said.

It is hardly necessary to call attention to the very diverse views held by areographers not only as to the interpretation to be put upon many of the markings observed on Mars —in particular, the geometrical network of the "canals"—but even as to their objective reality. Some optimists had hoped that photography would effectually dispose of all doubts on the latter point, and Mr. Lowell, indeed, has stated that his photographs have forever settled the matter. But one needs only to compare the drawing made by M. E. M. Antoniadi, himself an expert student of Martian topography, from forty of Mr. Lowell's photographs[2] with the direct prints from other photographs published by Mr. Lowell himself[3] to realize that the "doctors disagree" as earnestly as ever. It would seem that the time has come for the experts to reach some definite agreement on these questions, and it is because I have a suggestion to offer that appears to be practicable and that would, if followed, undoubtedly clear the atmosphere, that I, who am merely an interested student, not an expert, have ventured to write this note.

Mr. Percival Lowell has long been known as the chief advocate of the view that the Martian "canals" and other delicate surface markings on the planet which he has so fully observed and described are objective realities, and that they offer unmistakable evidence of intelligent life on the planet. He has not only published his observations and conclusions in detail in technical publications, but he has also written several popular books on Mars— "science that reads like romance"—to support these views. He has also claimed over and over again that his telescope and his geographical location give him facilities for

[1] It is rather amusing, by the way, to note that some of our European friends seem to have missed entirely the point of this remark and have, indeed, taken it so seriously as to be offended!

[2] *Monthly Notices Royal Astronomical Society*, Vol. LXIX, p. 110, 1908.

[3] *Proceedings of the Royal Society of London*, Series A, Vol. 177, p. 132, 1906.

Martian study not enjoyed by any one elsewhere.

Suppose, then, that Mr. Lowell invite two or three other well-known expert students of planetary detail—say, for example, Mr. E. E. Barnard, of the Yerkes Observatory; Mr. W. H. Pickering, of Harvard College Observatory, and Mr. E. M. Antoniadi, of l'Observatoire de Juvisy—to come to Flagstaff and join him in observing Mars at its next opposition. Would not astronomers and the public generally accept as objective realities any surface markings observed, either visually or photographically, by all four of these experts?

These experts might perhaps also undertake, during their residence at Flagstaff, to verify the remarkable and intricate network of markings on the planets Venus[4] and Mercury[4] which have been seen at the Lowell Observatory, and only there, so far as I am aware, and which, to the uninitiated, present many points of resemblance to the "canal" system on Mars. The fact that all the members of the Lowell Observatory staff are able to see so many of these markings which, apparently, are invisible from other stations, would seem to lend additional interest to my suggestion.

Great as have been Mr. Lowell's services in stimulating zeal in planetary studies, in no way, I think, could he add more to the sure advancement of our knowledge in this field than by inviting such a committee of experts to share with him, for a time, the advantages offered by his excellent telescope and favorable atmosphere.

R. G. Aitken

December 8, 1909

[4] For the markings on Mercury see *Popular Astronomy*, Vol. IV., p. 360, 1897; for the markings on Venus, *The Popular Science Monthly*, Vol. LXXV., p. 521, 1909.

SCIENTIFIC BOOKS

The Human Body and Health. An Intermediate Text-book of Essential Physiology, Applied Hygiene and Practical Sanitation for Schools. By Alvin Davidson, M.S., A.M., Ph.D., Professor of Biology in Lafayette College. New York, American Book Company.

This is an aggressive book. It abounds in plain statements that attract the reader and lead him on.

The author's motive and plan is indicated in the preface as follows:

> A few minutes' reflection in regard to the modern ways of living will fix in the mind of the sound reasoner the conviction that we are a careless and cruel people. Nearly one thousand human beings in the United States are dying daily of diseases which science has shown how to prevent. Streams are polluted, garbage dumped on the nearest vacant lot, fresh air and sunshine shut out of the houses by double doors and windows, and innocent children fed dirty milk because people do not realize that these acts are responsible for many of the four thousand graves daily made in our nation's cemeteries.
>
> Sanitary science and the public health can be advanced only as they are supported by an intelligent public opinion; . . . new ideas are grasped most readily by the young. Parents do not recognize that eyesight is being impaired, normal growth prevented, blood poisoned and the body starved because of customs and habits born in ignorance. . . . Anatomy and physiology is of little value to our young folks unless it helps them to practise intelligently in their daily lives the teachings of hygiene and sanitation. . . . Specific facts and full explanations are given showing how disease is caused and how the body may be kept well and strong. . . .

The contents of the book are as follows: Chapter I., The Human Body as a Living Machine; chapter II., Plants and Animals Related to Health; chapter III., The Plan of the Human Body; chapter IV., Food for the Body; chapter V., The Care and Cooking of Food; chapter VI., How Food is Used by the Body; chapter VII., Drink and Health; chapter VIII., Tobacco and other Narcotics and their Effect on Health; chapter IX., The Blood and its Passage through the Body; chapter X., Breathing and its Use; chapter XI., Air and Health; chapter XII., Cleanliness and Warmth; chapter XIII., Clothing and Colds; chapter XIV., The Bones; chapter XV., The Muscles and Exercise; chapter XVI., How the Body is Governed; chapter XVII., The Care of the Nervous System and

how Narcotics Effect it; chapter XVIII., Organs for Receiving Knowledge; chapter XIX., The Cause of Sickness; chapter XX., How to Keep Well.

The book is well supplied with illustrative cuts which for the most part are fairly good. The representation of the tubercle bacillus on page fifteen is hardly typical of that organism. The red-blood cells are described as cup-shaped (p. 79). This is, or has been, the teaching in the Harvard laboratories, but is not generally accepted.

The eustachian tube is represented as entering the middle ear at a level lower than that of the fenestra rotunda and inferior margin of the tympanum (p. 177).

A few criticisms of the text may be advanced as follows:

Page 15: Measles is given as a bacterial disease. This has not yet been proved. The author recognizes that fact on page 191.

Page 16: It is stated that "our common disease bacteria do not have spores. . . ." The bacillus of tetanus that figures so extensively in our Fourth of July mortality is a spore-forming bacterium; the bacillus of tuberculosis is thought at times to show spore formation; other pathogenic spore-forming bacteria are the bacillus of anthrax, the bacillus of malignant œdema.

Page 18: "Yellow fever and . . . are caused by tiny animals. . . ." This is probably true, but the fact remains that the specific cause of yellow fever has not yet been demonstrated.

Page 19: It is stated that the ova of head lice may be removed by washing the hair "two or three times" with "soap and equal parts of vinegar and hot water." This is a disappointing treatment. The patient is lucky if he escapes without a close hair cut. At best the ova may otherwise be removed only by hours of careful combing.

Page 35: The question is asked: "Why is it harmful to eat more than the body needs?" According to some of our best authorities it is impossible not to eat more than the body needs.

Page 37: Scarlet fever is referred to as a bacterial disease. The fact that the specific cause of this disease has not been found is recognized on page 191.

Page 44: Reference is here made to mucus as having "the power to kill many harmful bacteria and thus protect the body from disease." Our authorities on the flora of the normal mouth, nose and throat tell us that these regions may contain a score or more of varieties of bacteria, including such forms as the staphylococcus and streptococcus pyogens, pneumococcus, bacillus of diphtheria and the meningococcus.

Page 50: A description of "stomach digestion" is given here with no reference to the fact established by Cannon that salivary digestion is continued for some time after the food has reached the cardia.

Page 67: The carbonated drinks are here stated to be healthful when used in moderation. It must not be forgotten that soda water, ginger ale, and so on, are responsible for a great deal of indigestion. The specialists in our large skin clinics spend a good deal of time proscribing these drinks.

Pages 90 and 122: Turpentine and alcohol are recommended as antiseptic washes for fresh wounds. This is severe treatment. Turpentine and alcohol are very painful when applied to raw surfaces.

Page 107: ". . . impure air is heavy and near the floor." This statement is startling. In view of the fact that it is at variance with the teachings of hygiene for many years, it must be backed up with a careful array of significant experimental facts before it can be credited. The single experiment offered in the text does not suffice.

Page 121: "To avoid dandruff, the scalp should be thoroughly washed with soap and warm water once or twice a month." The avoidance of dandruff is not so simple. If much reliance is placed on this advice it will lead to disappointment.

Page 194: ". . . and numerous cases are on record where the use of milk from sick cows has given the disease [tuberculosis] to children." There is good reason for being afraid of milk from tubercular cows in spite of the fact that some of our very best authorities are not disposed to agree that there are numerous

authentic cases of human tuberculosis from this source.

A special effort is made throughout this book to present the evil effects of the use of alcohol and tobacco. This is legitimate and worthy, but one can not help asking if it is not overdone. Young people are not stupid. It is not wise to place extreme statements before them. They are very likely to discover that some of the most successful men in every branch of life smoke or drink more or less. They may find the practise in their own deservingly respected parents. They are likely to ask if the fishes on pages 72 and 111, which died in twenty-five minutes from the poison soaked out of tobacco placed in their aquaria would not have died just as quickly if tea leaves or coffee grounds or boiled cauliflower, onions or table olives had been substituted for the tobacco; or if any other smoke passed through the aquarium of the fish on page 168 would not have been as disastrous as the tobacco smoke which took that fish's life. These experiments should be checked up with controls. There are enough indisputable facts pointing to the evil effects of alcohol and tobacco to furnish sufficient argument against their unwise use.

THOMAS A. STOREY

COLLEGE OF THE CITY OF NEW YORK

Catalogue of the Lepidoptera Phalænæ in the British Museum. Volume VII., 1908; Volume VIII., 1909. By Sir GEORGE F. HAMPSON, Bart.

The present volumes deal with part of the subfamily Acronyctinæ of the family Noctuidæ. This subfamily will be treated in three volumes, of which these are the first and second. Volume VII. comprises 843 species in 96 genera, Volume VIII., 720 species in 104 genera. The key to the genera of the Acronyctinæ given in Volume VII. is reprinted in Volume VIII. with some additions and corrections and with the references to pages added. A large number of the genera are new, and their appearance in print without citation of species under them is rather unfortunate, as the proper citation of species will not occur until Volume IX. appears. In the meantime, students using the tables are liable to make use of these names. As we understand the rules, such use would appropriate the authorship of the generic names, and we have ourselves avoided using them on several occasions. Sir George Hampson follows the general plan of the preceding volumes, so useful and well received by the entomological public. It goes without saying that the majority of our familiar names are changed. But this is something that we have learned to expect and is, indeed, quite unavoidable, as never before have the moths of the world been consistently classified by an author so capable in the subject and so well supplied with material. An incidental result of the continued appearance of these volumes is the enabling of the general student to determine North American noctuids independently. Heretofore, there have existed no general tables of genera and species anywhere nearly up to date, so that it has been practically necessary for the last thirty years to refer doubtful specimens to a single student who has made this field his own. The relief now being afforded from this condition is gratifying.

HARRISON G. DYAR

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VII., No. 1, issued December 21, contains the following: "The Iodine Complex in Sponges (3,5-Diiodotyrosine)," by Henry L. Wheeler and Lafayette B. Mendel. Decomposition of ordinary bath sponges by barium hydrate yields 3,5-diiodotyrosine (iodgorgoric acid). "On the Preparation and Properties of Iodomucoids," by Gustave M. Meyer. Treatment of tendomucoid with iodine in alkaline solution produces iodo-mucoids, containing about 14 per cent. of organic iodine. "Lactic Acid in the Autolyzed Dog's Liver," by Tadasu Saiki. The lactic acid formed in liver autolysis is largely sarcolactic acid. "Liquid Extraction with the Aid of Soxhlet's Apparatus," by Tadasu Saiki. An adaptation of the usual form of Soxhlet's apparatus for extraction of liquids. "A Study of the Chemistry of Cancer: II., Purin Bases, Creatin and Creatinin," by Tadasu Saiki. Analyses of

fresh carcinomata. "A Note on the Estimation of Purin Nitrogen in Urine," by Stanley R. Benedict and Tadasu Saiki. Preliminary addition of acetic acid to urine makes the Krüger-Schmid method more accurate. "On the Neutrality Equilibrium in Blood and Protoplasm," by Lawrence J. Henderson. An answer to Robertson (*Journ. Biol. Chem.*, VI., p. 313, 1909). "Observations on the Influence of Lactic Acid Ferments upon Intestinal Putrefaction in a Healthy Individual," by Helen Baldwin. Addition of lactobacilline, bacillac or zoolak to diet did not diminish urinary evidence of intestinal putrefaction. "The Catalytic Action of Amino-acids, Peptones and Proteins in Effecting Certain Syntheses," by H. D. Dakin. Condensation (*in vitro*) of furfurol and malonic acid to furfuracrylic acid may be accomplished by the catalytic action of glycocoll. A number of similar reactions are described. "Note on the Urorosein Reaction," by H. D. Dakin. Criticism of work of Ciusa and Terni. "Notes on the Action of Sodium Benzoate on the Multiplication and Gas Production of Various Bacteria," by C. A. Herter. Sodium benzoate in a concentration of 0.1 per cent. only slightly or moderately inhibits intestinal bacteria. Gas-production may be considerably diminished. Inhibition of the *B. coli* group is greater than that of coccal forms.

THE AMERICAN MATHEMATICAL SOCIETY

The sixteenth annual meeting of the society was held at Boston on Tuesday, Wednesday and Thursday, December 28–30, 1909, in affiliation with the American Association for the Advancement of Science. Tuesday afternoon was devoted to a joint session with Sections A and B of the association. A joint session was held with Section A on Wednesday morning, the program consisting of Professor Keyser's vice-presidential address "On the Thesis of Modern Logistic," a report by Professor D. E. Smith on "The Work of the International Commission on the Teaching of Mathematics," and the first two papers in the list below. Separate sessions of the society were held on Wednesday afternoon and on Thursday morning and afternoon. On Tuesday evening several members took advantage of an invitation to attend the dinner and smoker of the Association of Mathematics Teachers in New England. The annual dinner of the society took place on Wednesday evening, forty-seven members gathering for this agreeable occasion. Much credit for the success of the meeting must be given to the local committee on arrangements, Professors Tyler, Bartlett and Bouton.

The total attendance at the annual meeting included sixty-one members of the society. Ex-president H. S. White and Professor E. W. Brown occupied the chair alternately during the several sessions. The following persons were elected to membership: Professor R. M. Barton, Dartmouth College; Dr. J. R. Conner, Johns Hopkins University; Miss Eva M. Smith, London, England. Nine applications for membership were received.

The reports of the treasurer, auditing committee and librarian will be published in the Annual Register, now in press. The membership of the society has increased during the past year from 601 to 618, including at present 58 life members. The number of papers presented at all meetings during the year was 149. The total attendance of members at the meetings was 311. The treasurer's report shows a balance of $8,003.78, of which $3,581.70 is credited to the life-membership fund. Sales of the society's publications during the year amounted to $1,748.90. The library has increased to nearly 3,300 volumes. A separate catalogue of the library, corrected to January 1, 1910, will soon be issued.

At the annual election, which closed on Thursday morning, the following officers and other members of the council were chosen:

Vice-Presidents—L. E. Dickson, J. I. Hutchinson.

Secretary—F. N. Cole.

Treasurer—J. H. Tanner.

Librarian—D. E. Smith.

Committee of Publication—F. N. Cole, E. W. Brown, Virgil Snyder.

Members of the Council (to serve until December, 1912)—D. R. Curtiss, L. P. Eisenhart, J. C. Fields, P. F. Smith.

The following papers were read at this meeting:

F. L. Griffin: "Certain tests comparing areas and other geometrical magnitudes."

G. A. Miller: "Groups generated by two operators s_1, s_2 satisfying the equation $s_1s_2^2 = s_2s_1^2$."

H. M. Sheffer: "Total determinations of deductive systems with special reference to the algebra of logic."

R. G. D. Richardson: "The Jacobi criterion in

the calculus of variations and the oscillation of solutions of m linear differential equations of the second order with m parameters."

J. V. McKelvey: "The groups of birational transformations of algebraic curves of genus five."

J. L. Coolidge: "The representation by means of circles of the imaginary elements of a three-dimensional domain."

L. C. Karpinski: "Jordanus Nemorarius and John of Halifax."

H. H. Mitchell: "The subgroups of the collineation group of the finite plane, $PG(2p)$."

W. H. Jackson: "Differential and integral equations arising out of the theory of radiation."

G. D. Birkhoff: "The stable solutions of the problem of three bodies."

W. D. Cairns: "The solution of the Lagrange equation in the calculus of variations by means of integral equations."

Arthur Ranum: "On the line geometry of riemannian space."

H. F. MacNeish: "Linear polars of quantics which are completely reducible to the product of linear forms."

E. V. Huntington: "An elementary explanation of the precession of a gyroscope."

C. J. Keyser: "Relational groups."

Edward Kasner: "Thomson and Tait's theorem on conservative forces."

Edward Kasner: "Note on Lamé's families connected with dynamics."

Arthur Ranum: "On Clifford parallels and Clifford surfaces in riemannian space."

The Chicago Section of the society held its twenty-sixth regular meeting at the University of Chicago on Friday and Saturday, December 31–January 1, the program including twenty-five papers. The next meeting of the society falls on Saturday, February 26. The San Francisco Section will meet on the same day at Stanford University.

F. N. COLE,
Secretary

SOCIETIES AND ACADEMIES

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE

THE thirty-sixth meeting was held at the Rockefeller Institute for Medical Research on December 15, 1909, with President Lee in the chair.

Members present: Atkinson, Auer, Banzhaf, Beebe, Brodie, Cole, Famulener, Gay, Gies, Harris, Jackson, Joseph, Kast, Lamar, Lee, Levene, Levin, Lewis, Lusk, Mandel, Maury, Meltzer, Morgan, Murlin, Morse, Opie, Pearce, Rous, Shaffer, Shaklee, Van Slyke, Wallace, Wolf.

Members elected: Stanley R. Benedict, Alfred F. Hess, A. W. Hewlett, J. F. McClendon, Raymond Pearl, A. I. Ringer, A. O. Shaklee, Sutherland Simpson and Hugh A. Stewart.

Scientific Program

"The Conglutination Reaction as a Method of Serum Diagnosis in Acute Infections," F. P. Gay and W. P. Lucas.

"Analysis of the Cleavage Products of the Nucleoprotein of the Mammary Glands," John A. Mandel.

"Respiration by Continuous Intra-tracheal Insufflation of Air" (a demonstration), S. J. Meltzer and J. Auer.

"Demonstration of Animals whose Thoracic Organs have been Operated upon," A. Carrel.

"The Mutual Life-saving Antagonistic Action of Barium and Magnesium" (a demonstration), D. R. Joseph and S. J. Meltzer.

"Acute Anaphylactic Death in Guinea-pigs: Its Cause and Possible Prevention" (a demonstration), J. Auer and P. A. Lewis.

"Anaphylactic Shock in the Dog," R. M. Pearce.

"The Cause of Serum Anaphylactic Shock and some Methods of Alleviating it," J. F. Anderson and W. H. Schultz.

"A Model Illustrating the Mode of Action of the Glomerulus," J. G. Brodie.

"The Influence of Glycerin on Gastric Secretion," L. Kast.

"The Summation of Stimuli," Frederic S. Lee and Max Morse.

"The Action of Magnesium Salts: (*a*) In Relation to Motor Nerve Impulses, (*b*) In Relation to Sensory Stimulation," A. H. Ryan and F. V. and C. C. Guthrie.

"The Effects of Direct Application of Magnesium Salts: (*a*) To Motor and Sensory Nerves, (*b*) To Cardio-inhibitory Nerves," C. C. and F. V. Guthrie and A. H. Ryan.

"The Survival and Growth of Subcutaneously Engrafted Ovarian and Testicular Tissue," C. C. Guthrie.

"The Survival of Engrafted Thyroid and Renal Tissue," C. C. Guthrie.

"The Effect of Anemia and of Double Hyperemia on Hyperplastic Goiter," C. C. Guthrie.

"A Method for the Determination of Amino-nitrogen and its Applications," Donald D. Van Slyke.

"Note on the Production of Glycosuria by Pan-

creatic, Parathyroid and Infundibular Extracts," Isaac Ott and John C. Scott.

"The Immunity of the Eggs of *Ciona intestinalis* to its 'own' Spermatozoa," T. H. Morgan.

"A Report on Experimental Poliomyelitis," Simon Flexner and Paul A. Lewis.

"The Influence of Thyroid-parathyroid-ectomy on the Ammonia Destroying Power of the Liver," A. J. Carlson and Clara Jacobson.

"The Relation of Ptyalin Concentration to the Diet and to the Rate of Salivary Secretion," A. J. Carlson and A. L. Crittenden.

"On Non-specific Complement Fixation," Hideyo Noguchi.

"Experimental Cirrhosis of the Liver," Eugene L. Opie.

"Shaking Experiments with Protozoa," Max Morse.

Eugene L. Opie,
Secretary

THE ACADEMY OF SCIENCE OF ST. LOUIS

The academy met at the Academy Building, 3817 Olive St., Monday, December 20, 1909, at 8 P.M., President Trelease in the chair.

Dr. Victor E. Emmel, of the anatomical department of Washington University, presented a paper entitled, "Observations on the Differentiation of Regenerating Epidermal and Striated Muscle Tissue," illustrated with a number of slides under the microscope.

Professor Nipher presented some of the results of his recent work on electric discharge. He has devised a series of experiments on the separately grounded terminals of an electric machine, which prove conclusively that the negative terminal is in a condition of compression, and that the positive is in a condition of electric rarefaction. The negative glow is a discharge of negative electricity from the negative wire to the air and surrounding objects. The positive glow is a flow of negative particles from surrounding bodies and from the air, to the positive side of the machine.

The evidence was obtained by passing the positive and negative wires to separate grounds, through high resistances, consisting of wetted strings. Between these resistances and the machine terminals, these wires pass in a horizontal direction over photographic plates. Other independent ground wires terminate just below the center of the plates, and under the wires.

In a spark discharge from the positive terminal negative electrons pass upward from the ground wire and fog the central part of the film from the under side. Negative discharges, flowing over the top of the film to the positive wire, curve around the fogged area. They are repelled by it. On the other plate negative electrons pass downward from the lower side of the plate to the ground wire. The central area of the plate does not repel the outflowing discharge from the negative wire to the film. On the contrary, it attracts them. The discharge lines over the film are nearly parallel, but diverge slightly at their outermost ends.

Mary J. Klem,
Librarian

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

The fourth regular meeting of the session of 1909–10 was held at the Chemists' Club on January 7.

The following papers were read:

"The Origin of the Chemical Elements," by Henry B. Russell.

"Chemical Examination of Watermelon Seed" and "Chemical Examination of Pumpkin Seed," by F. B. Power and A. H. Salway.

"Further Researches in the Quinazoline Field," by C. G. Amend and M. T. Bogert.

C. M. Joyce,
Secretary

RHODE ISLAND SECTION

The regular meeting of the section was held at the University Club on Thursday evening, December 2, at seven o'clock, preceded by the usual informal dinner.

Dr. H. J. Wheeler, director of the Rhode Island Agricultural Experiment Station at Kingston, R. I., read the paper for the evening and a large audience listened to the interesting report which he presented. His subject was "The Influence of Sodium and Potassium Salts upon the Subsequent Yield of Potato Tubers planted under Like Manurial Conditions."

The results obtained showed that when potatoes that had been grown with a predominance of sodium salts in the soil and those that had been grown with a predominance of potassium salts were planted side by side under identical conditions and manured equally, the best yield was obtained from the tubers that had been grown in the soil containing the extra sodium.

Albert W. Claflin,
Secretary

Providence, R. I.

SCIENCE

FRIDAY, JANUARY 28, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SCIENCE AS SUBJECT-MATTER AND AS METHOD[1]

ONE who, like myself, claims no expertness in any branch of natural science can undertake to discuss the teaching of science only at some risk of presumption. At present, however, the gap between those who are scientific specialists and those who are interested in science on account of its significance in life, that is to say, on account of its educational significance, is very great. Therefore I see no other way of promoting that mutual understanding so requisite for educational progress than for all of us frankly to state our own convictions, even if thereby we betray our limitations and trespass where we have no rights save by courtesy.

I suppose that I may assume that all who are much interested in securing for the sciences the place that belongs to them in education feel a certain amount of disappointment at the results hitherto attained. The glowing predictions made respecting them have been somewhat chilled by the event. Of course, this relative shortcoming is due in part to the unwillingness of the custodians of educational traditions and ideals to give scientific studies a fair show. Yet in view of the relatively equal opportunity accorded to science to-day compared with its status two generations ago, this cause alone does not explain the unsatisfactory outcome. Considering the oppor-

[1] Address of the vice-president and chairman of Section L, Education, American Association for the Advancement of Science, Boston, 1909.

tunities, students have not flocked to the study of science in the numbers predicted, nor has science modified the spirit and purport of all education in a degree commensurate with the claims made for it. The causes for this result are many and complex. I make no pretense of doing more than singling out what seems to me one influential cause, the remedy for which most lies with scientific men themselves. I mean that science has been taught too much as an accumulation of ready-made material with which students are to be made familiar, not enough as a method of thinking, an attitude of mind, after the pattern of which mental habits are to be transformed.

Among the adherents of a literary education who have contended against the claims of science, Matthew Arnold has, I think, been most discreetly reasonable. He freely admitted the need of men knowing something, knowing a good deal, about the natural conditions of their own lives. Since, so to say, men have to breathe air, it is advisable that they should know something of the constitution of air and of the mechanism of the lungs. Moreover, since the sciences have been developed by human beings, an important part of humanistic culture, of knowing the best that men have said and thought, consists in becoming acquainted with the contributions of the great historic leaders of science.

These concessions made, Matthew Arnold insisted that the important thing, the indispensable thing in education, is to become acquainted with human life itself, its art, its literature, its politics, the fluctuations of its career. Such knowledge, he contended, touches more closely our offices and responsibilities as human beings, since these, after all, are to human beings and not to physical things. Such knowledge, moreover, lays hold of the emotions and the imagination and modifies character, while knowledge about things remains an inert possession of speculative intelligence.

Those who believe, nevertheless, that the sciences have a part to play in education equal—at the least—to that of literature and language, have perhaps something to learn from this contention. If we regard science and literary culture as just so much subject-matter, is not Mr. Arnold's contention essentially just? Conceived from this standpoint, knowledge of human affairs couched in personal terms seems more important and more intimately appealing than knowledge of physical things conveyed in impersonal terms. One might well object to Arnold that he ignored the place of natural forces and conditions *in* human life and thereby created an impossible dualism. But it would not be easy to deny that knowledge of Thermopylæ knits itself more readily into the body of emotional images that stir men to action than does the formula for the acceleration of a flying arrow; or that Burns's poem on the daisy enters more urgently and compellingly into the moving vision of life than does information regarding the morphology of the daisy.

The infinitely extensive character of natural facts and the universal character of the laws formulated about them is sometimes claimed to give science an advantage over literature. But viewed from the standpoint of education, this presumed superiority turns out a defect; that is to say, so long as we confine ourselves to the point of view of subject-matter. Just because the facts of nature are multitudinous, inexhaustible, they begin nowhere and end nowhere in particular, and hence are not, just as facts, the best material for the education of those whose lives are centered in quite local situations and whose careers are irretrievably partial and specific. If we

turn from multiplicity of detail to general laws, we find indeed that the laws of science are universal, but we also find that for educational purposes their universality means abstractness and remoteness. The conditions, the interests, the ends of conduct are irredeemably concrete and specific. We do not live in a medium of universal principles, but by means of adaptations, through concessions and compromises, struggling as best we may to enlarge the range of a concrete here and now. So far as acquaintance is concerned, it is the individualized and the humanly limited that helps, not the bare universal and the inexhaustibly multifarious.

These considerations are highly theoretical. But they have very practical counterparts in school procedure. One of the most serious difficulties that confronts the educator who wants in good faith to do something worth while with the sciences is their number, and the indefinite bulk of the material in each. At times, it seems as if the educational availability of science were breaking down because of its own sheer mass. There is at once so much of science and so many sciences that educators oscillate, helpless, between arbitrary selection and teaching a little of everything. If any questions this statement, let him consider in elementary education the fortunes of nature-study for the last two decades.

Is there anything on earth, or in the waters under the earth or in the heavens above, that distracted teachers have not resorted to? Visit schools where they have taken nature study conscientiously. This school moves with zealous bustle from leaves to flowers, from flowers to minerals, from minerals to stars, from stars to the raw materials of industry, thence back to leaves and stones. At another school you find children energetically striving to keep up with what is happily termed the "rolling year." They chart the records of barometer and thermometer; they plot changes and velocities of the winds; they exhaust the possibilities of colored crayons to denote the ratio of sunshine and cloud in successive days and weeks; they keep records of the changing heights of the sun's shadows; they do sums in amounts of rainfalls and atmospheric humidities—and at the end, the rolling year, like the rolling stone, gathers little moss.

Is it any wonder that after a while teachers yearn for the limitations of the good old-fashioned studies—for English grammar, where the parts of speech may sink as low as seven but never rise above nine; for text-book geography, with its strictly inexpansive number of continents; even for the war campaigns and the lists of rulers in history since they can not be stretched beyond a certain point, and for "memory gems" in literature, since a single book will contain the "Poems Every Child Should Know."

There are many who do not believe it amounts to much one way or the other what children do in science in the elementary school. I do not agree, for upon the whole, I believe the attitude toward the study of science is, and should be, fixed during the earlier years of life. But in any case, how far does the situation in the secondary schools differ from that just described? Any one who has followed the discussions of college faculties for the last twenty-five years concerning entrance requirements in science, will be able to testify that the situation has been one of highly unstable equilibrium between the claims of a little of a great many sciences, a good deal (comparatively) of one, a combination of one biological and one exact science, and the arbitrary option of the pupil of one, two or three out of a list of six or seven specified sciences.

The only safe generalization possible is that whatever course a given institution pursues, it changes that course at least as often as the human organism proverbially renews its tissues. The movement has probably tended in the direction of reduction, but every one who has followed the history of pedagogical discussion will admit that every alteration of opinion as to what subjects should be taught has been paralleled by a modification of opinion as to the portions of any subject to be selected and emphasized.

All this change is to some extent a symptom of healthy activity, change being especially needed in any group of studies so new that they have to blaze their own trail, since they have no body of traditions upon which to fall back as is the case with study of language and literature. But this principle hardly covers the whole field of change. A considerable part of it has been due not to intelligent experimentation and exploration, but to blind action and reaction, or to the urgency of some strenuous soul who has propagated some emphatic doctrine.

Imagine a history of the teaching of the languages which should read like this: "The later seventies and early eighties of the nineteenth century witnessed a remarkable growth in the attention given in high schools to the languages. Hundreds of schools adopted an extensive and elaborate scheme by means of which almost the entire linguistic ground was covered. Each of the three terms of the year was devoted to a language. In the first year, Latin and Greek and Sanskrit were covered; in the next, French, German and Italian; while the last year was given to review and to Hebrew and Spanish as optional studies."

This piece of historic parallelism raises the question as to the real source of the educational value of, say, Latin. How much is due to its being a "humanity," its giving insight into the best the world has thought and said, and how much to its being pursued continuously for at least four years? How much to the graded and orderly arrangement that this long period both permitted and compelled? How much to the cumulative effort of constant recourse to what had earlier been learned, not by way of mere monotonous repetition, but as a necessary instrument of later achievement? Are we not entitled to conclude that the method demanded by the study is the source of its efficacy rather than anything inhering in its content?

Thus we come around again to the primary contention of the paper: that science teaching has suffered because science has been so frequently presented just as so much ready-made knowledge, so much subject-matter of fact and law, rather than as the effective method of inquiry into any subject-matter.

Science might well take a leaf from the book of the actual, as distinct from the supposititious, pursuit of the classics in the schools. The claim for their worth has professedly rested upon their cultural value; but imaginative insight into human affairs has perhaps been the last thing, save *per accidens*, that the average student has got from his pursuit of the classics. His time has gone of necessity to the mastering of a language, not to appreciation of humanity. To some extent just because of this enforced simplification (not to say meagerness) the student acquires, if he acquires anything, a certain habitual method. Confused, however, by the tradition that the subject-matter is the efficacious factor, the defender of the sciences has thought that he could make good his case only on analogous grounds, and hence has been misled into resting his claim upon the superior significance of his special subject-matter;

even into efforts to increase still further the scope of scientific subject-matter in education. The procedure of Spencer is typical. To urge the prerogative of science, he raised the question what knowledge, what facts, are of most utility for life, and, answering the question by this criterion of the value of subject-matter, decided in favor of the sciences. Having thus identified education with the amassing of information, it is not a matter of surprise that for the rest of his life he taught that comparatively little is to be expected from education in the way of moral training and social reform, since the motives of conduct lie in the affections and the aversions, not in the bare recognition of matters of fact.

Surely if there is any knowledge which is of most worth it is knowledge of the ways by which anything is entitled to be called knowledge instead of being mere opinion or guess-work or dogma.

Such knowledge never can be learned by itself; it is not information, but a mode of intelligent practise, an habitual disposition of mind. Only by taking a hand in the making of knowledge, by transferring guess and opinion into belief authorized by inquiry, does one ever get a knowledge of the method of knowing. Because participation in the making of knowledge has been scant, because reliance on the efficacy of acquaintance with certain kinds of facts has been current, science has not accomplished in education what was predicted for it.

We define science as systematized knowledge, but the definition is wholly ambiguous. Does it mean the body of facts, the subject-matter? Or does it mean the processes by which something fit to be called knowledge is brought into existence, and order introduced into the flux of experience? That science means both of these things will doubtless be the reply, and rightly. But in the order both of time and of importance, science as method precedes science as subject-matter. Systematized knowledge is science only because of the care and thoroughness with which it has been sought for, selected and arranged. Only by pressing the courtesy of language beyond what is decent can we term such information as is acquired ready-made, without active experimenting and testing, science.

The force of this assertion is not quite identical with the commonplace of scientific instruction that text-book and lecture are not enough; that the student must have laboratory exercises. A student may acquire laboratory methods as so much isolated and final stuff, just as he may so acquire material from a text-book. One's mental attitude is not necessarily changed just because he engages in certain physical manipulations and handles certain tools and materials. Many a student has acquired dexterity and skill in laboratory methods without its ever occurring to him that they have anything to do with constructing beliefs that are alone worthy of the title of knowledge. To do certain things, to learn certain modes of procedure, are to him just a part of the subject-matter to be acquired; they belong, say, to chemistry, just as do the symbols H_2SO_4 or the atomic theory. They are part of the arcana in process of revelation to him. In order to proceed in the mystery one has, of course, to master its ritual. And how easily the laboratory becomes liturgical! In short, it is a problem and a difficult problem to conduct matters so that the technical methods employed in a subject shall become conscious instrumentalities of realizing the meaning of knowledge —what is required in the way of thinking and of search for evidence before anything

passes from the realm of opinion, guess work and dogma into that of knowledge. Yet unless this perception accrues, we can hardly claim that an individual has been instructed in science. This problem of turning laboratory technique to intellectual account is even more pressing than that of utilization of information derived from books. Almost every teacher has had drummed into him the inadequacy of mere book instruction, but the conscience of most is quite at peace if only pupils are put through some laboratory exercises. Is not this the path of experiment and induction by which science develops?

I hope it will not be supposed that, in dwelling upon the relative defect and backwardness of science teaching I deny its absolute achievements and improvements, if I go on to point out to what a comparatively slight extent the teaching of science has succeeded in protecting the so-called educated public against recrudescences of all sorts of corporate superstitions and silliness. Nay, one can go even farther and say that science teaching not only has not protected men and women who have been to school from the revival of all kinds of occultism, but to some extent has paved the way for this revival. Has not science revealed many wonders? If radio-activity is a proved fact, why is not telepathy highly probable? Shall we, as a literary idealist recently pathetically inquired, admit that mere brute matter has such capacities and deny them to mind? When all allowance is made for the unscrupulous willingness of newspapers and magazines to publish any marvel of so-called scientific discovery that may give a momentary thrill of sensation to any jaded reader, there is still, I think, a large residuum of published matter to be accounted for only on the ground of densely honest ignorance. So many things have been vouched for by science; so many things that one would have thought absurd have been substantiated, why not one more, and why not *this* one more? Communication of science as subject-matter has so far outrun in education the construction of a scientific habit of mind that to some extent the natural common sense of mankind has been interfered with to its detriment.

Something of the current flippancy of belief and quasi-scepticism must also be charged to the state of science teaching. The man of even ordinary culture is aware of the rapid changes of subject-matter, and taught so that he believes subject-matter, not method, constitutes science, he remarks to himself that if this is science, then science is in constant change, and there is no certainty anywhere. If the emphasis had been put upon method of attack and mastery, from this change he would have learned the lesson of curiosity, flexibility and patient search; as it is, the result too often is a blasé satiety.

I do not mean that our schools should be expected to send forth their students equipped as judges of truth and falsity in specialized scientific matters. But that the great majority of those who leave school should have some idea of the kind of evidence required to substantiate given types of belief does not seem unreasonable. Nor is it absurd to expect that they should go forth with a lively interest in the ways in which knowledge is improved and a marked distaste for all conclusions reached in disharmony with the methods of scientific inquiry. It would be absurd, for example, to expect any large number to master the technical methods of determining distance, direction and position in the arctic regions; it would perhaps be possible to develop a state of mind with American people in general in which the supposedly keen American sense of humor would react when it is

proposed to settle the question of reaching the pole by aldermanic resolutions and straw votes in railway trains or even newspaper editorials.

If in the foregoing remarks I have touched superficially upon some aspects of science teaching rather than sounded its depths, I can not plead as my excuse failure to realize the importance of the topic. One of the only two articles that remain in my creed of life is that the future of our civilization depends upon the widening spread and deepening hold of the scientific habit of mind; and that the problem of problems in our education is therefore to discover how to mature and make effective this scientific habit. Mankind so far has been ruled by things and by words, not by thought, for till the last few moments of history, humanity has not been in possession of the conditions of secure and effective thinking. Without ignoring in the least the consolation that has come to men from their literary education, I would even go so far as to say that only the gradual replacing of a literary by a scientific education can assure to man the progressive amelioration of his lot. Unless we master things, we shall continue to be mastered by them; the magic that words cast upon things may indeed disguise our subjection or render us less dissatisfied with it, but after all science, not words, casts the only compelling spell upon things.

Scientific method is not just a method which it has been found profitable to pursue in this or that abstruse subject for purely technical reasons. It represents the only method of thinking that has proved fruitful in any subject—that is what we mean when we call it scientific. It is not a peculiar development of thinking for highly specialized ends; it *is* thinking so far as thought has become conscious of its proper ends and of the equipment indispensable for success in their pursuit.

The modern warship seems symbolic of the present position of science in life and education. The warship could not exist were it not for science: mathematics, mechanics, chemistry, electricity supply the technique of its construction and management. But the aims, the ideals in whose service this marvelous technique is displayed are survivals of a pre-scientific age, that is, of barbarism. Science has as yet had next to nothing to do with forming the social and moral ideals for the sake of which she is used. Even where science has received its most attentive recognition, it has remained a servant of ends imposed from alien traditions. If ever we are to be governed by intelligence, not by things and by words, science must have something to say about *what* we do, and not merely about *how* we may do it most easily and economically. And if this consummation is achieved, the transformation must occur through education, by bringing home to men's habitual inclination and attitude the significance of genuine knowledge and the full import of the conditions requisite for its attainment. Actively to participate in the making of knowledge is the highest prerogative of man and the only warrant of his freedom. When our schools truly become laboratories of knowledge-making, not mills fitted out with information-hoppers, there will no longer be need to discuss the place of science in education.

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THE FUTURE OF THE MEDICAL PROFESSION[1]

Mr. President and Colleagues: We are here to rejoice over the union of the Ohio and the Miami Medical Colleges, which

[1] An address on University Day, December 1, 1909, at the University of Cincinnati.

have become one school, the medical department of the University of Cincinnati. Each of these schools has an honorable history. Leaders and pioneers in the profession have made up their faculties, and men of most honorable record are to be found among their graduates. This amalgamation has been accomplished at much personal sacrifice on the part of some connected with each institution. When any institution of the rank and prestige held so many years by each of these schools loses its individuality some of the dreams of the past must come to naught. This is by no means an isolated instance of the merger of medical schools within the past few years in this country. In various sections this has already been accomplished. The number of medical schools is decreasing and this decrease is being brought about by the profession itself. Not only is the number of medical schools being diminished, but in all the better medical schools the bars to admission are being raised higher each year. This is a commercial age and this is preeminently a commercial country, and yet the medical profession is ridding itself of commercialism. It is demanding of those who desire to enter its ranks a higher degree of culture and intelligence than is demanded of any other profession in this country. The average requirement for admission to our best medical schools is at least two years ahead of that demanded for admission to other professional schools, and after admission, from one to two years more of time is demanded for graduation. Our best medical schools are demanding a more advanced preliminary education of their matriculates, and more time in the course, and yet the financial inducements to enter the profession are falling year by year. It requires not only more time but more money to enter the medical than any other profession. In our universities in which both law and medicine are taught the students in the two schools pay practically the same tuition and annual fees, while in addition to these the medical student must pay extra laboratory expenses. A young man in my own state may, after finishing his high school, enter the law department of the university and graduate after three years, or, if he chooses, he may read law in an office for fifteen months, then enter the law school and graduate after two years. If he wishes to study medicine, after completing his high school course, he must spend at least two years in the collegiate department of the university before he can enter upon his medical studies, for which four more years are required.

Every state in the union has a minimum legal requirement for the practise of medicine, and in some this requirement is high enough to exclude all save those who have had the best training. This restriction is for the benefit of the people, and not in the interests of the profession. Unfortunately, these legal enactments fail to reach many pseudo-medical practitioners who still prey upon the credulity of the public, such as the nostrum vender, the advertising charletan, the abortionist *et omne id genus*.

The medical profession is giving liberally of its energy, time and money in every branch of sanitation. It is doing its best in the restriction and prevention of disease. Many of our best men are serving on state, municipal and village boards of health, often without any pecuniary remuneration, and in practically all instances without adequate financial reward. The physician not only pays the taxes upon what property he possesses, but day and night he is rendering extra service to the poor of his community, and it must be admitted that many of the well-to-do trespass upon his generosity. The clinic established for the

treatment of the poor is crowded with the rich, often to the practical exclusion of those for whose benefit the charity was intended.

Let us see what the condition of the medical man in this country is to-day. In order to enter a good medical school, he must have a better preliminary education than is demanded for admission to any other professional school. Having gained admission, he must spend more money and take more time in order to gain his degree than any other profession demands. Then the young man with his degree finds it highly advantageous to take one or more years of hospital work for which he receives no financial remuneration. Before he can offer his services to the public he must pass a state examination which is more rigid than that demanded of any other profession. Finally, having hung out his sign, he walks to his dispensary or hospital, where he offers his dearly bought skill and experience to the deserving poor, many of whom ride to the same place in costly motor cars. He serves without recompense upon boards of health, and does his best to prevent disease upon the existence of which his bread and butter depend. He writes papers and gives lectures upon sanitation, and the more his advice is accepted and followed, the smaller is the number of his paying patients. When he is treating a case of any infectious disease the physician, in preventing the spread of the infection, is rendering a service to the public, which as a rule is unrecognized and seldom rewarded. In legislative halls he is crowded aside by the followers of pseudo-medicine. If his name gets into the daily papers favorably in connection with any case under his charge, his professional brethren scold, while the bold advertisement of the nostrum vender, the so-called specialist and the abortionist stare at him from the pages of both the secular and religious press. He lectures on the prevention and eradication of tuberculosis, telling how people should live in order to prevent this disease. He says that outdoor life, good, wholesome food and sanitary surroundings are the essentials, and he helps to make up the millions annually required on account of the postal deficiency, while the government mail carries to the remotest corners of the county the lying promises of so-called consumption cures. He attempts to show how intemperance saps the health of body and mind and fills our asylums, while the most deadly forms of alcohol are freely sold at exorbitant prices under the delusive names of stomach bitters, celery compound, peruna, etc. He shows the deteriorating effect of venereal disease. He tells that a large per cent. of his gynæcological operations results from this cause, while the "restorer of lost manhood" sprinkles the pages of the Sunday newspaper with his nauseating "ads." He pays a high duty on the imported microscope with which he watches the agglutination of typhoid bacilli in his early recognition of the disease, preparatory to recommending measures that may avert the epidemic, while the sugar trust bribes the custom inspector and the corporation accumulates its millions. He pays a double price for the knife with which he removes the cancerous breast of the poor woman, because the steel trust must declare a dividend.

Twenty years ago there were many medical schools in this country, owned and controlled by their faculties, to the members of which there came either directly or indirectly each year a fair financial return on the investment. It did not cost much to inaugurate and maintain a medical school at that time. A suitable building with one or two large lecture rooms, a gar-

ret for a dissecting room, a small chemical laboratory, a museum with specimens from the clinic and some inexpensive apparatus for demonstrating the elements of physics and chemistry were the essentials. The session was only six months, and two sessions completed the course. The lectures were repeated each year and both classes attended the same lectures. Possibly some member of the faculty had a microscope, which might be seen, protected from the dust, under a glass case. It was rumored among the students that a drop of water seen through this instrument had been found to be teeming with life. Rarely some professor was bold enough to actually use the microscope, and possibly he exhibited diatoms, uric acid crystals and sections of bone.

This is all changed. The medical building with all needed laboratories and equipment costs hundreds of thousands of dollars. Skilled men giving their entire time to the work are demanded in all the laboratory branches, and even the clinician has but little time for outside remunerative work.

I do not think that I have overdrawn the picture of the present conditions of the medical man in this country. The medical schools that were paying properties thirty years ago are now being donated to the universities. Medical education has become so expensive that it can be provided only by institutions that are endowed or receive financial support from the state or the municipality. The advance made in medical education in this country in the past ten years is greater than that of any other profession. To fit one for the practise of medicine, higher preliminary training, more time and more money are required. Notwithstanding these things, the average income of the medical practitioner in this country is decreasing year by year. He does much for the public good for which he receives neither recognition nor reward. As a member of this profession I am making these statements without the slightest bitterness and even without complaint, because I believe that the profession is preparing itself to do the greatest good for the race, that it is in training to render mankind the highest service, and that its members in the near future must be leaders in an evolution such as the world has never known. I am by no means sure that the profession in general is to be credited with being conscious of the great work that lies before it, or of preparing itself for the high station to which it is to be called. The civilized world has reached a period in its evolution in which the educated medical man must play an important part. Without his help the development of the race can not proceed as it should. Man has reached a period in his development when he has become conscious of the fact that the great work of advancing his race towards physical, intellectual and moral perfection is a duty which falls upon himself. The creature has been elevated to the dignity and power of a creator and this imposes upon him a responsibility that he may not and can not avoid.

The history of civilization is being rewritten, and in the light of to-day there is being read into it a lesson that the world can not ignore. History has heretofore dealt almost exclusively with questions of politics, with literature, customs, manners, etc. The influence of disease upon the decline and fall of nations has been until recently overlooked. Professor Jones has shown quite conclusively that the plasmodium of malaria was the greatest factor in the decay of Greek civilization and did much to render the once virile Roman an easy victim to the more robust Goth and Vandal. The buried cities of Asia and

northern Africa fell into ashes under the withering curse of disease. In Spain the Moors reached a high degree of civilization. They built the wonderful city of Cordova and filled its great library with the most advanced science of the day. This people supplied the most skilful physicians of the time. Returned to Africa, their descendents degenerated into the barbarians whom to-day we know as the Riffs of Morocco.

Civilized people have come to a realization of the fact that disease constitutes the greatest bar to human progress, and that nation which first frees itself from the bondage of disease will dominate all others. In that land the superman will first be born. Two conditions are essential before any nation can free itself from disease. In the first place it must possess an educated, scientific medical profession. In the second place, the nation as a whole must be guided by the advice of its best medical men. With either of these conditions wanting no people will be able to advance.

Are we, the people of the United States, held in the bondage of disease? One out of every seven of us die of tuberculosis; fifty thousand of us perish annually of typhoid fever, and ten times this number lie stricken for weeks each year with this disease, but ultimately recover. Pneumonia disputes with tuberculosis the right to be called the captain of death. Some 50,000 of us die annually of cancer and other malignant growths, more than 25 per cent. of our children die before they reach five years of age. In short, more than 80 per cent. of us die from causes that are preventable, and which the enlightened nation of the future will prevent.

I am not sure that our nation will be able to fully comply with either of the conditions mentioned. I do know that the better medical schools in this country are doing their best to prepare the profession of the future for this work. Encouragement in regard to the second condition comes from the general interest shown in the recently developed campaign against tuberculosis, the large and small contributions in aid of this work and the ready response made by many of our state legislatures in the enactment of laws tending to restrict this and other infectious diseases; also from the generous contributions that have recently been made for the study and abatement of uncinariasis and pellagra. We, of the profession, have frequent cause for impatience with the laity for their indifference towards matters of public health, but we should remember that the attitude of the world towards the causation of disease can not be suddenly and completely changed. Disease has for countless generations been regarded as of divine or mystic origin, as an infliction from heaven, sent either in love or in anger. This old superstition still casts its shadow over us and consciously or unconsciously influences the conduct of many. It is difficult for a nation within a generation to cast off the superstitions of the fathers. This can be done, however, by instructing the children in sanitary matters. Leibnitz said: "Give me control of education for a generation and I will change the world."

What will be some of the functions of the medical man of the future? In my opinion, the most important of these may be grouped in certain classes, and it is of the greatest importance that these should be fully appreciated, especially by those interested in medical education. In the first place, that nation will be most favorably situated which does the most for the prosecution of medical research. Every scientific medical discovery so far made has been a blessing to mankind. Medicine has not been advanced by philosophical dogma; it has grown and has yielded its rich and

beneficent fruits only as a result of slow, laborious research. The chemist, bacteriologist, pathologist and clinician have obtained results, not by sitting in their studies or libraries and evolving theories from their inner consciousness, but by experimentation and close, accurate observation in their laboratories, and at the bedside. For more than a thousand years before the time of Pasteur there were occasional medical men who believed that certain diseases are spread by living contagions. In the fifth century before our era Empedocles of Agrigento taught that stagnant water breeds disease and he is said to have delivered the city of Selinunte from an epidemic of fever by draining a swamp in the vicinity. And yet, in the year 1905, twenty-four centuries later, according to Ross, out of a total population of about two and one half millions in Greece not less than one million had malaria and nearly six thousand died from this disease. About two thousand years ago Varro in his "Rerum rusticarum," in advising concerning the location of a country house, wrote as follows: "Adimadvertendum etiam si qua erunt loca palustria, et proter easdem causas, et quod crescunt animalia quædam minuta, quæ non possunt occuli consequi, et per æra intus in corpus, per os ac nares perveniunt atque difficiles efficiunt morbos," and yet the plasmodium of malaria devastated the fair fields of southern Italy and continued to hold sway, awaiting the time when a French army surgeon, Laveran, at an isolated post in the same malaria-ridden Africa, should demonstrate the cause of this disease, the giant enemy to the civilization of the Mediterranean coast. Then came the researches of Ross and others by which the part played in the distribution of malaria by the mosquito was demonstrated, and now the fertile lands of the Roman campagna promise to become the home of a busy, contented and happy people. Findlay thought that a certain mosquito might be a factor in the distribution of yellow fever, but this was demonstrated to be a fact only by the careful and heroic investigations of Reed and his colleagues. Small-pox was well-nigh universal until the careful observations and practical experiments of Jenner relieved man of the heavy tribute that he paid to this disease in death and disfigurement. Anthrax and hydrophobia levied a heavy tax on both man and beast until brought under man's control by the genius of Pasteur. Diphtheria with its death rate of from 50 to 60 per cent. alarmed the physician and awakened the horror of the community until the patient labors of Behring and Roux gave the world antitoxin. The beneficent action of anesthesia was foreshadowed by Davy and brought to full realization by the experiments of Long, Wells, Jackson and Morton. The true nature of tuberculosis was brought to light by the studies of Vilemin and Koch, and upon the knowledge thus gained it is within the power of man to stamp out this and other infectious diseases. A list of the great discoveries of scientific medicine is too long to give fully. This investigation into the causation and prevention of disease is not complete, it is barely begun. No disease that afflicts man or beast is thoroughly understood; in all cases the knowledge in the possession of the wisest medical man is but fragmentary, and in regard to the nature of many diseases we are still in complete ignorance. For instance, we know practically nothing as yet of the cause of cancer and but little of that of insanity. We are just beginning to practise vaccination against typhoid fever and other acute infections. The greatest problem that lies before the most advanced nations to-day is to free themselves from

disease, and this can be accomplished in only one way, and that is, the development and maintenance of medical research. This is a national and community problem, and that nation which does this most generously and most wisely will dominate the world, because it will become the strongest and the best. At present it must be admitted that Germany is in the lead, and the predominance of the German is due to his universities and the encouragement that he has given to scientific research. American medical research grows stronger year by year. There are numerous laboratories that are turning out most creditable work, but we need more of them and better equipment for those we have. The nation, the several states and the large cities can make no better investment than that given for the purpose of widening the knowledge necessary to keep the people in health. We may reasonably hope that the discoveries to be made in our laboratories will tend to decrease poverty, diminish sickness, prolong life, increase the effectiveness of the individual, add to the comfort and contentment of the people, and give to our country in the coming generations stronger and better men and women. A certain number of medical men of the future must give their lives to research work. However, this number will always be relatively small.

It is my intention to speak especially of the medical practitioner of the future. This individual's duties are to be quite different from those of the medical practitioner of the past, and if the world is to profit, as I hope it may, by the aid of medical science, the attitude of the profession toward the public and that of the public toward the profession must radically change. Heretofore the medical man has been taught from the beginning of his professional studies that he must not talk about professional matters to the laity. He has been made to feel that his duty is to practise and not to preach. To a certain extent this is wise and must hold for the future, as it has for the past. The practise of the profession, so far as the relations of physician and patient are concerned, is sacred and must not become matter for gossip. All understand this and no man worthy to be a member of the profession will for a moment forget or cease to hold sacred his relation to his patient. But the medical man of the future must become a public teacher, instructing his community and advising with those in authority concerning the good of the whole. In doing this he must use, in a proper manner, of course, the usual avenues of reaching the public, such as the popular magazine and the daily newspaper. Up to the present time the only instructor of the public in matters pertaining to disease has been the charlatan who has made extensive use of the daily press. This must be altered for the public good. The medical man must disseminate through this and other avenues the knowledge necessary to combat disease, and there has been nothing more encouraging in the attempt, just now begun, and of necessity led by the profession, to stamp out tuberculosis and to diminish the other infectious diseases than the readiness with which the newspapers of this country have taken up the matter. The national antituberculosis society is sending twice a month material bearing on this subject to hundreds of newspapers, and they are making proper use of it. I know of no reputable newspaper that has declined to participate in this great work. The best and most accurate information concerning the prevention of disease must be diffused through the masses. The medical man of the future must talk and write on these subjects not exclusively for the benefit of

his fellows in the profession, but especially for those outside of it. Ignorance concerning these matters is appalling not only among the uneducated but among the educated as well. There are many teachers in our public schools, not only in the primary and secondary schools, but in our colleges and even in our universities as well, who are in absolute ignorance of the most elementary principles of hygiene. There are master architects planning our buildings, both public and private, who have no knowledge of ventilation. They may produce imposing elevations and design beautiful cornices and pleasing facades, but they are ignorant of the proper distribution of air and light. I predict that the time does not lie many generations in the future when many of the national, state and municipal buildings upon which the present looks with pride will be regarded as relics of a barbaric, at least a semi-barbaric, past. There are members on our public water commissions who could not distinguish between a typhoid bacillus and a yeast plant. As a rule, the men who enact our laws, both national and state, know nothing of that greatest asset that a people may have, which is health. Sometimes this amounts to a national calamity. I need only refer to the fact that when we last assembled a great army, within less than three months, and without seeing the enemy, nearly one fifth of those who enlisted were incapacitated by disease. This was due essentially to two things. First, Congress in its stupidity and ignorance had failed to make proper provision for the medical service. There was not a microscope in a camp in the United States army in 1898, so far as I know, until the necessity for its use was made evident by thousands of cases of typhoid fever, at first wrongly diagnosed as malaria—a mistake that could not have been made had the medical service been equipped as the then surgeon general wished it to be. But Congress would not listen to the man who was regarded by many of its members as only a scientific crank. In the second place, the line officer of that time, and no one appreciates his high average character more than I do, and I saw much of him, was too often deaf to his medical assistant and comrade. Shortly after the Japanese-Russian war I had occasion to compliment a high medical officer of the former nation on the low Japanese death rate from disease, when he replied: "We know nothing more about the hygiene of armies than you do. In fact, what we do know we learned from America and Europe, but our line officers accepted our advice so far as was possible."

Health is, as I have stated, a nation's best asset, and yet the sums devoted to maintaining the health of our people by the nation and by the several states are paltry in the extreme.

We need not worry about a low birth rate, but we should regard a high death rate as a national disgrace and a sign of national decay. As the race grows wiser and stronger in body and intellect these rates quite naturally approach the same level. This was made plain by Herbert Spencer more than fifty years ago. No nation that neglects the health of its people can hope to endure, and that government that secures for its citizens the longest average life in health is the best, whatever its tariff laws may be. These facts are being understood more or less thoroughly by some of the most advanced nations, and in doing this work the medical profession must lead the way. The medical educators of this country realize this much more fully than any one else can, and laying aside personal ambitions and especially pecuniary considerations, they are striving to prepare

for the next generation a profession made up of men of broad culture and of special scientific skill. This is the explanation of mergers in medical colleges, of the rapid advance in the requirements for admission to medical schools, and for the extension of the course. The medical man of the future must be a leader in all that pertains to the highest welfare of his country. His help is necessary in order to relieve the people from the bondage of disease.

Permit me to briefly point out some of the specific ways in which the medical profession can be of benefit to the people. The civilized world is awakening to the knowledge that the infectious diseases are preventable, the most enlightened of the nations are adopting measures to prevent them, and there is to be a healthy rivalry among the countries to see which can do this first and in the most effective manner. This is demonstrated by the crusade now being inaugurated against tuberculosis. We may reasonably expect improved methods in the treatment of this disease, and such knowledge as will give this to us must come as a result of the labors of scientific medical men. But the great effort must be made in its prevention, and this is, and will continue to be, a community problem, into which the nation, the state and the locality must throw their best and wisest efforts. Knowledge of the nature of the disease, its avenues of dissemination, and the means necessary for its restriction, must come into the possession of all classes and conditions, and the medical profession must be the source of this information. The practical application of this knowledge must be directed by the same body of men. The practitioner must recognize the disease in its incipient stages, before the infected individual becomes a possible center for the infection of others, and while the process in himself can be arrested. This will be demanded of every physician in the future, and the people must learn wisdom enough to go to the doctor before it is too late. Sanitoria and hospitals for the education and treatment of the infected must be provided by the public. This attempt to restrict and eradicate so grave and widespread a disease is the greatest and most beneficent undertaking that man has ever assumed, but it is not a visionary dream. It is a herculean task, but one not beyond the accomplishment of intelligence and effort.

Typhoid fever and other diseases, disseminated so frequently by contaminated water and milk, need not exist, and the heavy tribute that we pay annually to these infections is not complimentary to either our intelligence or our brotherly love, one for the other. The millions that we lose every year in deaths from these diseases would, if properly expended, soon place a safe water supply in every city and village.

It is time for us to stop attempting to control the venereal diseases by moral suasion. A false modesty has prevented us from talking about these distempers, and they should be added to the list of dangerous and communicable diseases, and every person found infected with one of them should be put in custody until he or she is free from the infection.

The time will come, if the world is to progress in intelligence, when every person will undergo a thorough examination at the hand of a skilful physician twice or oftener, each year. An official record of each such examination will be made, and no two consecutive examinations will be made by the same physician; and after death an autopsy will be made. Then the careless and unskilled physician will soon find himself without a vocation.

The world has never been in greater need of the enlightened medical man than it is

likely to be in the next generation, and the world will demand that he be worthy of the tasks that will fall upon him. No other profession will be able to render greater service to mankind. The incentive to enter the profession is not likely to be great, measured in the coin of the realm, but measured by the good done to the race, there will be none greater. The function of the new, combined medical department of the University of Cincinnati will be to prepare properly its students for worthy service in that profession which has always labored for the uplift of mankind.

A regular and frequent thorough physical examination of every citizen must be adopted by the people if the race is to be freed from disease. The good that can be accomplished by this is not limited to the infectious diseases. There are many disorders of metabolism which, if detected in time, may be arrested or cured. I will at present refer to only one of these. There are many men and women just passing the prime of life who are developing a glycosuria. At first this is in many instances a pathological condition that is easily controlled by a proper diet. Often it begins with a diminished capacity on the part of the individual to properly dispose of a few special carbohydrates. Which these are should be determined and eliminated from the daily food. In his ignorance the individual continues to eat the food which for him has become a poison. After some months or years the condition grows more grave. The person becomes incapable of properly metabolizing any carbohydrate and finally he can no longer utilize the carbohydrate group in his protein food. Having reached this point, the individual becomes cognizant of the fact that he is not well and he goes to his physician, but the condition is now incurable.

This is given simply as an illustration of the great good that an educated medical profession might render the public by constant supervision of the public health, but in order to bring this about both the profession and the public must be educated along scientific lines. It must be begun among the more intelligent, and its good results becoming apparent, it will be adopted by all. In Michigan University this work has been started. Every medical student must submit to a thorough physical examination each semester, and if any abnormality be detected, the individual must follow rules and regulations if he is to continue in the school. We hope in a few months to extend this to the students of all departments of the university. There is no better place to begin this beneficent work than in our institutions of higher learning. With us no student will be permitted to use the gymnasium until he is found by actual examination to be free from venereal disease, and any one attending the gymnasium may be called upon to submit himself to an examination at any time. Those having other physical defects will be placed under such restrictions as the medical men may impose.

The nation that will profit in the future from the labors and discoveries of the medical profession must help in this cause. It must make large appropriations for scientific research. It must render financial aid to medical education, which has become too costly for the profession itself to provide, and it must not permit of the use of short roads to practise. While the advanced medical educator in this country is doing his best to elevate his profession, pseudo-medicine is filling the lobbies of every state capitol with demands for legal recognition, and too often it happens that our law makers are not wise enough to distinguish between the true and the false. This imposes a heavy duty upon the profession, and

that is the one which I have already emphasized—the education of the public. To one who has had occasion to interview our legislators, both national and state, in behalf of public health affairs, the situation often becomes most depressing. The task seems hopeless and one is inclined to forego all effort. Men high in the councils of the nation say without hesitation that this talk about stamping out tuberculosis is only a doctor's fad. As one listens to such talk, as I have, from high sources, his national pride hides its face in shame and he wonders to what destination his country is drifting with such colossal ignorance guiding its course. But, as medical educators our duty is clear, and it has fallen to us to prepare the next generation of those who will be able to render a far greater service to human progress than the world has yet seen. With the race freed from disease, both inherited and acquired, the better man will be born and will dominate the earth. I am not enough of a prophet to predict anything concerning the nationality of the superman who is to come and possess the earth, but he will not come to a disease-ridden people, for the intellectuality and morality of a nation depend upon its physical health, and the historian of the future will have no difficulty in convincing his readers that we who lived in the early part of the twentieth century were not so wise as we believed ourselves to be, as he points out our high mortality rate from preventable diseases, and shows what feeble efforts were made to prevent them.

VICTOR C. VAUGHAN

THE NUMBER OF STUDENTS IN GERMAN UNIVERSITIES

SOME statistics regarding the number of students in the twenty-one German universities, which have lately appeared in the *Frankfurter Zeitung*, may be of interest to the readers of SCIENCE.

The number of students matriculated in the summer semester of 1909 reached the total of 51,510, as compared with 48,717 in the winter of 1908–09, and 47,799 in the preceding summer.

In thirty years the increase has been as follows:

Year	No. of Students	Per 100,000 Population
1879	19,771	43.7
1889	29,491	——
1899	33,563	——
1909	51,510	78.4

The relative increase in the principal subdivisions may be shown in the following table:

	Number 1879	Number 1909	Per 100,000 Population 1879	Per 100,000 Population 1909
Philological and historical studies	2,724	7,690	10.6	20.6
Mathematics and natural science	1,563	3,503	6.1	9.4
Law	3,179	7,259	12.3	19.5
Medicine	2,061	4,879	8.0	13.1
Theology (evangelical)	1,036	1,211	5.9	5.6
Theology (catholic)	330	1,014	3.5	8.4
Pharmacy	301	896	1.2	2.4

It will be noted that the percentage increase in medicine has about kept pace with the increase in law, while the proportion of students in mathematics and natural science has not increased so rapidly as that in philological and historical studies. The number of students of evangelical theology shows a relative falling off (although a slight absolute increase), but catholic theology records a greater relative increase than any other subject.

Some interesting facts are also given respecting the extent and nature of inter-university migration. In the summer months of 1909, 28.6 per cent. of the Prussian students were registered in the German universities outside of Prussia, for the most part (18.7 per cent.) in the South German universities of Bavaria, Baden (Heidelberg and Freiburg) and Württemberg (Tübingen). On the other hand, only 5.8 per cent. of the Bavarian, 8.4 per cent. of the Baden and 10.7 per cent. of

the Württemberg students were matriculated in Prussian universities. In Heidelberg there were 763 Prussians and 654 Badenese, and in Freiburg 1,437 Prussians and 688 Badenese, a state of affairs probably due in large part to the attractive surroundings of the two Baden universities.

EDWIN O. JORDAN

LECTURES IN SANITARY SCIENCE AT COLUMBIA UNIVERSITY

THE committee in charge announces the following lectures in the course in sanitary science and public health for the second term, 1909-1910:

February 1—A. H. Seymour, Esq.: "The Development of Public Health Law and the State Control of Health."

February 3—A. H. Seymour, Esq.: "Provisions of Public Health Law as applied to Specific Regulation."

February 8—Dr. V. E. Sorapure: "Transmission and Prevention of some Infectious Diseases."

February 10—Dr. V. E. Sorapure: "Immunity."

February 15—Dr. James Ewing: "Cancer and its Relation to Public Health."

February 17—Dr. W. Gilman Thompson: "The Occupation Diseases of Modern Life."

February 22—Professor A. D. MacGillivray: "Insects and the Transmission of Disease."

February 24—Professor A. D. MacGillivray: "Insects and the Transmission of Disease."

March 1—Dr. John B. Huber: "Tuberculosis, its Nature and Causes."

March 3—Dr. John B. Huber: "Tuberculosis, its Prevention and Cure."

March 8—Hon. Homer Folks: "Voluntary Organization in Public Health Work."

March 10—Dr. John H. Pryor: "Results of Tuberculosis in New York State."

March 15—Dr. E. R. Baldwin: "Early Diagnosis of Tuberculosis."

March 17—Dr. D. M. Totman: "Local Quarantine Measures."

March 22—Dr. H. H. Crum: "The Supervision of Infectious Diseases."

March 24—Dr. H. W. Wiley: "Food Adulteration and its Effects."

March 29—Professor E. M. Chamot: "The Detection of Food Adulteration."

March 31—Professor E. M. Chamot: "The Detection of Food Adulteration."

April 5—Professor W. A. Stocking: "Dangers of Impure Milk."

April 7—Professor W. A. Stocking: "Dairy Hygiene."

April 12—Dr. L. H. Gulick: "School Hygiene."

April 14—Professor G. W. Cavanaugh: "Animal Wastes and their Disposal."

April 19—Professor H. N. Ogden: "The Relation of the Engineer to Sanitation."

April 21—Mr. Geo. C. Whipple: "Principles of Water Purification."

April 26—Mr. Theodore Horton: "Water Purification Plants."

April 28—Professor H. N. Ogden: "The Problem of Sewerage."

May 3—Mr. H. B. Cleveland: "Sewage Disposal Plants."

May 5—Professor Alfred Hayes: "The Law of Nuisances."

May 12—Rudolph Hering: "The Garbage Problem."

May 17—Professor C. A. Martin: "House Planning with reference to Health."

May 19—Professor C. A. Martin: "The Healthful House."

May 26—Professor G. N. Lauman: "Health in Rural Communities. Public Health."

SCIENTIFIC PUBLICATIONS FOR FREE DISTRIBUTION

ON January 13 a resolution was passed in the House of Representatives ordering the whole stock of the scientific publications named below in the House Folding Room to be disposed of in order to make room for new documents. Any reader of SCIENCE desiring to procure any of these documents should apply to the member of congress from the congressional district in which he resides *within sixty days* from the date of passage of this resolution.

The publications to be distributed free are as follows:

Geological Resources, Cripple Creek, Colo.

Geological Report on Mercur Mining District, Utah.

Astronomical Papers of the American Ephemeris, Vols. 5 and 6.

Catalogue, Prehistoric Works.

Indian Languages: Algonquin, Athapascan, Chinookan, Iroquoian, Muskhoegan, Salishan.

National Academy of Sciences.—*Memoirs:* Vols.

2, 3, 3 pt. 2, 5, 6, 8, 9. *Reports:* 1883, 1887 to 1889, 1891, 1895, 1906 to 1908.

Ohio Earthworks.

Geological Survey.—*Water Supply and Irrigation Papers:* Nos. 148, 153 to 232, 234, 235. *Bulletins:* Nos. 269, 275, 277 to 301, 303 to 379, 382 to 389, 392 to 395, 399 to 403. *Professional Papers:* Nos. 44 to 67. *Annual Reports:* 2d to 28th, 1880–81 to 1907.

Washington Astronomical Observations: 1881 to 1890.

Entomology: 1880–1885 (2 vols.).

Rocky Mountain Locusts (2 vols.).

Coast Survey Reports: 1872, 1886 to 1897–8, 1906.

Fish Commission Reports: Parts 3 to 29, 1877 to 1903.

Fish and Fisheries: 1904, 1905.

Nautical Almanac: 1885 to 1909.

SCIENTIFIC NOTES AND NEWS

A DEPARTMENT of experimental biology has been organized in the Rockefeller Institute. Professor Jacques Loeb, of the University of California, has been elected head of the department. He will begin his work at the Rockefeller Institute next autumn.

MR. GIFFORD PINCHOT has been elected president of the National Conservation Association. Dr. Charles W. Eliot, the first president of the association, has been elected honorary president.

A NATIONAL testimonial with a purse of $10,000 for Commander Robert E. Peary is planned for the evening of February 8, at the Metropolitan Opera House, New York City. Governor Hughes will preside. Commander Peary will tell the story of his trip to the pole and show new pictures of the far north.

AT a recent meeting of the board of trustees of Cornell University, in New York City, it was resolved on the motion of President Schurman that the secretary send the following telegram to Director Bailey: "The Trustees of Cornell University, assembled at the winter meeting, send cordial New Year's greeting to Director Bailey, and rejoice with him in the prospect of still greater work for the agricultural interests of the state, under his leadership, in the College of Agriculture of Cornell University."

AT a dinner given on January 18 in honor of Professor William James, professor emeritus of philosophy at Harvard University, a portrait of Professor James was presented to the university by the members of the division and by the visiting committee. The painting, which is by Miss Ellen Emmet, of New York, is of three-quarter length and life size. For the present it will hang in Emerson Hall, but eventually it will be placed in the faculty room of University Hall.

THE permanent portrait committee of the medical department of the University of Pennsylvania has, during the past few years, almost completed the collection of portraits of former professors in the Medical School. These portraits now hang in the halls and lecture rooms of the new medical laboratories and thus connect historically the new home of the medical department with memories and traditions of teachers of the past century and a half. Of the six professors not at present represented in this collection, one is Dr. Simon Flexner, who was professor of pathology for the years 1899 to 1903 and responsible, wholly or in part, for the instruction in pathology received by the classes of 1900 to 1905. A special committee consisting of representatives of these classes and of Dr. Flexner's associates and assistants during the years of his incumbency, has been appointed by the permanent portrait committee to take such action as may be necessary to procure Dr. Flexner's portrait.

ON his sixtieth birthday, January 14, Professor W. O. Crosby was presented with a silver loving cup by a number of present and past instructors in the department of geology of the Massachusetts Institute of Technology.

DR. RICHARD DEDEKIND, professor of mathematics in the Brunswick School of Technology, has been given an honorary doctorate of mathematics by the Zurich Polytechnicum.

OFFICERS of the Entomological Society of America have been elected as follows: *President,* Dr. John B. Smith; *First Vice-presi-*

dent, Dr. S. A. Forbes; *Second Vice-president,* Professor V. L. Kellogg; *Secretary-Treasurer,* C. R. Crosby; *Additional Members Executive Committee,* Professor J. H. Comstock, Dr. W. M. Wheeler, Mr. E. A. Schwarz, Professor L. Bruner, Rev. Professor C. J. S. Bethune, Professor J. M. Aldrich.

THE annual meeting of the council of the American Physical Education Association was held at the Rittenhouse Hotel, Philadelphia, on Saturday, January 1, 1910. The following officers were elected: *President,* Dr. George L. Meylan, Columbia University; *Secretary-editor-treasurer,* Dr. J. H. McCurdy, International Y. M. C. A. Training School, Springfield, Mass. The next convention of the association will be held in Indianapolis, March 1–3, in connection with the Department of Superintendents of the National Educational Association and the American School Hygiene Association.

DR. O. TETTENS, of Frankfort, has been appointed observer in the Aeronautical Observatory at Lindenberg, near Berlin.

DR. KARL GROOS, professor of philosophy and pedagogy at Giessen, has resigned his chair at the university.

DR. ALEXANDER G. RUTHVEN, of the University of Michigan, will conduct a zoological expedition to southern Mexico, during the coming summer.

DR. FREDERICK BEDELL, of the department of physics, at Cornell University, will spend the remainder of the year abroad on sabbatic leave.

DR. ALVIN S. WHEELER, associate professor of organic chemistry in the University of North Carolina, has been granted a year's leave of absence to study abroad. He will leave with his family for Germany on May 24.

DR. J. C. ARTHUR, of Purdue University, Indiana, is spending the month of January consulting the cryptogamic and phanerogamic collections of Harvard University, while Mr. Frank D. Kern, of the same institution, is engaged in similar work at the New York Botanical Garden. It is expected that another installment of the rusts of North America will soon be made ready for publication. As the rusts are strictly parasitic, the work requires an almost equal familiarity with the systematic position of fungi and the flowering hosts.

AT a stated meeting of the American Philosophical Society, on Friday evening, January 21, Dr. Ernest Fox Nichols, president of Dartmouth College, and late professor of experimental physics in Columbia University, read a paper entitled "Some Recent Investigations in Physics."

A JOINT meeting of the American Ethnological Society and the Section of Anthropology and Psychology of the New York Academy of Sciences was held at the American Museum of Natural History on Monday, January 24, when a public lecture was given by Professor Franz Boas, of Columbia University, on "The Changes in the Physical Characteristics of the Immigrants to the United States."

DR. L. A. BAUER addressed the students of physics and engineering at Northwestern University on January 12 and at the University of Cincinnati on January 14, his subject being "The Non-magnetic Yacht *Carnegie* and her Work."

ON January 14 Professor C. J. Keyser, of Columbia University, delivered a lecture at Princeton University on "Ways to Pass the Walls of the World; or, Scientific Speculations regarding the Figure and the Dimensions of Space."

AT McGill University the following are acting as special lecturers during the present session:

Professor J. F. Kemp, of Columbia University, on "The Application of Geology to certain Engineering Problems."

J. B. Tyrrell, Esq., F.G.S., on "The Geological Relations of Alluvial Gold Deposits, as Illustrated more Particularly by those of the Yukon District."

D. B. Dowling, Esq., of the Geological Survey of Canada, on "The Geology of Coal, with especial reference to the Coal Deposits of the Province of Alberta."

F. W. Cowie, Esq., C.E., chief engineer of the

Montreal Harbor Commission, on "The Construction and Development of Harbors."

WILLIAM GEORGE TIGHT, professor of geology and natural history at Denison University from 1887 to 1901 and since then until a few months ago president and professor of geology at the University of New Mexico, fellow of the Geological Society of America and of the American Association for the Advancement of Science, died at Glendale, Cal., on January 15, at the age of forty-five years.

Mr. William Abner Eddy, known for his work in aerial photography, has died at Bayonne, N. J., in his sixtieth year.

COLONEL GEORGE EARL CHURCH, born in Massachusetts in 1835, but latterly residing in England, known for his geographical work in various parts of the world, died on January 4.

DR. FRIEDRICH KOHLRAUSCH, author of the "Lehrbuch der praktischen Physik" and former president of the Physikalisch-Technische Reichsanstalt, died suddenly at his home at Marburg, Germany, on January 18.

DR. MORITZ GRESHOFF, director of the Colonial Museum at Haarlem, known for his work on physiological botany, has died at the age of forty-seven years.

THE late Darius Ogden Mills, of New York City, has bequeathed $100,000 to the American Museum of Natural History; $50,000 to the New York Botanical Garden and $25,000 to the American Geographical Society of New York City.

THE first Hookworm Conference was held in Atlanta, Ga., on January 18 and 19. The conference opened with about 500 in attendance and a representation from twelve states. Dr. Henry F. Harris, secretary of the Georgia State Board of Health, was elected temporary chairman and Mr. William Whitford, of Chicago, secretary. The principal speaker was Dr. Charles Wardell Stiles, U. S. Public Health and Marine-Hospital Service, Washington, D. C. A permanent organization was effected under the name "Southern Health Conference."

THE Boston *Transcript* reports that four interconnected projects for fisheries exhibits at South Boston are proposed. These are an aquarium, a fish culture station, a museum of the appliances, methods and industrial statistics of the fisheries, and a trade school for fishermen.

THE department of vertebrate paleontology of the American Museum of Natural History has received as a gift from Mr. Charles Lanier, one of the trustees, a skull of the Cretaceous dinosaur Triceratops. This specimen was collected in the Laramie Cretaceous of Seven-Mile Creek, Western County, Wyoming, about forty-five miles northwest of Edgemont, South Dakota, by Mr. Charles H. Sternberg.

THE Naples Table Association for Promoting Laboratory Research by Women announces that applications for the table supported by the association should be made before March 1. The fourth prize of $1,000 for a thesis containing laboratory research in biological, chemical or physical science will be awarded in April, 1911. Further information may be obtained from Mrs. A. D. Mead, 283 Wayland Avenue, Providence, R. I.

MR. ROOSEVELT has written from Nairobi, under the date of December 15, 1909, the following letter to the secretary of the Smithsonian Institution:

I have to report that the Smithsonian Expedition under my charge has now finished its work in British East Africa and is about to leave for Uganda. The collections made in British East Africa include:

Mammals, large, in salt	559
Mammals, small, in salt	3,379
Birds	2,784
Reptiles and batrachians, about	1,500
Freshwater and marine fish, about	250
Total vertebrates	8,463

In addition the collections include a large number of mollusks and other invertebrates; several thousand plants; in the neighborhood of two thousand photos; anthropological materials, etc.

Up to January 17 only a little over a quarter of the collections enumerated in Mr. Roosevelt's letter had reached the institution. In addition to the mammals mentioned by him, there have, however, already been received perhaps 150 skulls of large mammals which are

not associated with skins, these being picked up in the field for the study of the variations in individual specimens. Word has recently been received of the killing by Mr. Roosevelt of two specimens of the white rhinoceros, an adult female and calf. These will be of particular value to the museum which has no representative of this species in its collection.

CONSUL-GENERAL RICHARD GUENTHER, of Frankfort, writes that the Kosmos Association of Naturalists in Stuttgart, the Duerer League and the Austrian Imperial Association for Ornithology in Vienna have united in an address to the public calling for subscriptions to create a Natural Protective Park. This address was published last spring and since then has been followed up by a convention in Munich well attended by naturalists and scientific men from all parts of Germany. An organization was effected, called the Verein Naturschutzpark, with headquarters in Stuttgart. The plan is to create three large parks, one in the Alpine Mountain Range, one in the highlands of central Germany and the third in the low country of the north. The main object is to preserve and increase certain species of animal and plant life. The parks are expected to become centers of attraction and recreation for millions of people, natives and foreign visitors. The fee for membership to this park association will be quite low, to encourage hundreds of thousands to join.

UNIVERSITY AND EDUCATIONAL NEWS

THE trustees of Columbia University propose to remove the College of Physicians and Surgeons from its present location on West Fifty-ninth street to a commanding site on Morningside Heights, adjacent to the other schools of the university. A large part of the necessary land has been obtained by the gift of Messrs. William K. Vanderbilt, George J. Gould, Frank A. Munsey and a fourth anonymous contributor.

MR. J. S. HUYLER, of New York, has given $20,000 to Syracuse University.

THE Commonwealth Edison Company of Chicago and the General Electric Company of Schenectady have jointly presented to the department of electrical engineering of the University of Illinois a 125-kilowatt steam turbo-generator. The turbine of this unit is to be non-condensing. The generator is to be designed for 3-phase, 60-cycle currents, to be delivered at 2,300 volts. With the addition of this machine the electrical laboratory will be prepared to deal extensively with problems involving single-phase, quarter-phase and three-phase currents.

A MUSEUM of Industrial Chemistry has been established at the University of Illinois under the division of applied chemistry.

THE trustees of Cornell University have voted to meet the congestion in the department of chemistry by an extension of North Morse Hall westward a distance of about 40 feet, and the building committee was instructed to have the enlarged building ready for occupancy in September.

THE statement to the effect that Mrs. Phoebe A. Hearst has decided to erect for the University of California a museum of anthropology is incorrect. Mrs. Hearst explicitly denied the report the day after it appeared in the paper which first published the story.

AN anonymous donor has given to the University of Paris an annual income of 30,000 francs to found ten fellowships at foreign universities.

WE learn from the *Journal* of the American Medical Association that the council of the University of Paris and the Pasteur Institute have agreed to construct, at the joint expense of the two institutions, a laboratory for the study of the phenomena of radioactivity and their therapeutic applications. The projected laboratory will comprise two parts: one for scientific researches under the direction of Mme. Curie, the other for medical applications under the direction of the Pasteur Institute. The latter will contribute towards the expenses of construction and equipment of the institution 400,000 francs, from the Osiris legacy.

DR. WILLIAM HUNTINGTON, president of Boston University, proposes to retire at the end of the present academic year.

DR. EDMUND CLARK SANFORD will be installed as president of Clark College on February 1.

A. H. SUTHERLAND, Ph.D. (Chicago), of the Government Hospital for the Insane at Washington, has been appointed instructor in psychology in the University of Illinois.

DR. ISSAI SCHUR has been promoted to an associate professorship of mathematics in the University of Berlin.

DR. KNOLLER has been appointed associate professor of aeronautics in the Vienna School of Technology.

DR. DIETZIUS has qualified as docent for aeronautics in the Berlin School of Technology.

DISCUSSION AND CORRESPONDENCE

FALL OF A METEORITE IN NORWOOD, MASSACHUSETTS

DURING the night between October 7 and 8, 1909, a meteoric stone fell to earth on the farm of Mr. W. P. Nickerson, of Norwood, Mass. The meteorite is a ham-shaped mass of very hard gray stony material, much corrugated on the surface, about two and one half feet long in its greatest dimension, one foot to nearly one and one half feet broad, and varying from one foot to one half foot in the third dimension. I estimated its volume as about 1.75 cubic feet, its weight as perhaps 275 pounds, and its density as not much over 2.5. The material has a flow structure, like that of an ancient lava which has solidified during flow, but is completely crystalline. It is, therefore, entirely different from any meteorite on record. The stone is about as hard as petrosilex, and has a slight salty odor. Laminæ from 2 to 4 millimeters thick, perhaps on an average 5 to 10 mm. apart, disposed in a parallel order, project from the surface to the extent of several millimeters, resembling in this respect a much weathered piece of laminated felsite, except that there has been no chemical alteration of the superficial layer such as occurs in felsitic weathering. The laminæ are distinctly parallel, their general direction transverse to the longer axis of the mass. The projections, although rounded, exhibit a remnant of crystalline form. They are in fact phenocrysts of plagioclase feldspar. Several small cavities, a few millimeters in diameter, are recognizable, but the greater part of the surface is without any pitting, other than that of the normal, and everywhere present, structural corrugation.

The bolide fell vertically through the bars of a gateway, breaking every bar and burying itself in the sand directly underneath to a depth of three feet. It was this fresh break which attracted the attention of one of the farmer's men in the early morning of Friday, October 8. The top of the stone was about six inches below the level of the surface in the interior of a cavity in the ground not much over a foot wide. The top of the stone was still appreciably warm the following morning at 7 A.M., according to Mr. Nickerson, and the bottom was decidedly warm ("hot" is the word used by the man who first felt it). A neighbor, Miss Stuart, of Westwood, in whose candor and honesty I have complete confidence, arrived at the spot just after the stone had been exhumed, handled its surface without gloves, and declares that it was so hot that she did not care to keep her hands on it very long. One of Mr. Nickerson's hired men independently told me the same. The moisture in the surrounding earth had been converted into steam which, in blowing off during its escape, had brushed off, and thus cleansed the *lower* surface of the meteorite—the surface of impact—which was cleaner than the upper surface, a fact which attracted the attention and surprise of the diggers who could not account for it. The sand had been so thoroughly dried that it sifted back into the hole as the stone was pried out, although the surrounding soil of the pasture was damp. The bolide passed through the bars so swiftly that the rather weak side supports were not injured. One hard wood bar was cut with a sharp fracture. Some smaller and weaker ones were more or less torn.

It seems to me probable that when a bolide succeeds in penetrating to the denser layers of the atmosphere at a very low angle, the up-

ward elastic reaction of the air becomes so great that the meteorite rebounds, but if the angle of the path is a high one, atmospheric friction and impact retard the meteoric velocity to so great an extent that gravity gets the victory, and the last part of the meteor's fall is vertical. If this conclusion is correct, there should be some evidence that bolides which strike the ground fall more often than not in a vertical direction. I am not aware that such evidence has been sought, or especially noted. The present instance is so well authenticated, that it seems worth putting on record. Subsequent investigation has proved that the fall of the meteorite occurred at about quarter before seven o'clock on the evening of Thursday, October 7, as witnessed by several people in Norwood.

FRANK W. VERY

WESTWOOD, MASS.,
October 12, 1909

A LABORATORY ILLUSTRATION OF BALL LIGHTNING

IN Dr. Elihu Thomson's address at the opening of the Palmer Physical Laboratory at Princeton University he made, with regard to ball lightning, the statement, "The difficulty here is that it is too accidental and rare for consistent study, and we have not as yet any laboratory phenomena which resemble it closely."[1] This suggested to me that a phenomenon which I witnessed some six or seven years ago might be worth recording.

With a copper wire a student accidentally short-circuited the terminals of an ordinary 110-volt circuit. I happened at the time to be a few meters from him and to be looking toward the terminals. At the instant of the short circuit I saw an incandescent ball which appeared to roll rather slowly from the terminals across the laboratory table and then disappeared. As I remember it, I should say that the ball may have appeared to be about three centimeters in diameter. I think no one else in the room saw anything more than a flash of light—much as if a fuse had blown. On the table where the ball had rolled we found a line of scorched spots, as if the ball had bounced along the table and had scorched the wood wherever it touched. As I remember them, these scorched spots were rather close together, perhaps not more than one or two centimeters apart. In the top of the table was a crack perhaps a millimeter or two wide, and at this crack the scorched line ended. In a drawer immediately under this crack we found a tiny copper ball, perhaps a millimeter in diameter. Apparently the ball that rolled along the table was incandescent copper vapor, although my memory of it is rather of a yellow-white than of a greenish light.

The above suggested the possibility of a laboratory study of a phenomenon which may very possibly be similar to that of ball lightning, but I have never attempted to repeat the experiment.

A. T. JONES

PURDUE UNIVERSITY

[1] SCIENCE, XXX., p. 868, December 17, 1909.

BALL LIGHTNING

TO THE EDITOR OF SCIENCE: In the address on "Atmospheric Electricity" by Professor Elihu Thomson, on pages 867 to 868 in the issue of December 17, reference is made to lightning in the form of a ball of fire. This calls to my mind an experience which I had some fifteen years ago while watching a heavy electrical storm. I observed what appeared to be a ball of fire between two and three feet in diameter rolling along the street. It was also accompanied by several others of smaller size. This appearance occurred just after a very heavy electrical discharge to a telephone pole some few squares away. The discharge along the telephone wire heated the wire to red heat. The wire broke on account of this heating and a section of some considerable length was hurled along the street with a whirling motion. The rapidity of the rolling motion gave the appearance of a ball, as it also gave a forward motion to the ball of fire. Subsequent investigation revealed the two ends of the wire dangling from adjacent poles with a considerable length of the wire missing. I beg to suggest that the rapid heating of metal particles in some manner similar to this may be the cause of many of the so-called balls of lightning.

LOUIS M. POTTS

BALTIMORE, MD.,
January 10, 1910

THE CIVILIZATION OF BOHEMIA

WITH reference to Dr. Hrdlička's article in SCIENCE of December 17, p. 880, it may be of interest to note the prominence of Bohemia in zoological research. In gathering material for the "Directory of Zoologists," I have obtained biographical data from fourteen prominent zoologists resident in Prag, namely, Babák, Počta, v. Lendenfeld, Stölc, Klapálek, Perner, Rádl, Babor, Frič, Vejdovsky, Němec, Srdinko, Steinach, Völker. Any zoologist looking at this list will recognize familiar names. Prag in 1900 had a population of 204,498. There are many cities in America which could not make nearly so good a showing; for example, New Orleans, with a population of 287,104; or Los Angeles and Denver combined, with a population between them of 236,338.

T. D. A. COCKERELL

ENGINEERING STUDENT STATISTICS

TO THE EDITOR OF SCIENCE: President Howe, of the Case School of Applied Science, has called my attention to an error which in some strange way crept into the table of engineering student statistics that was published in the issue of SCIENCE for June 4, 1909. In the table the number of students is given as 479 in 1907–8 and 431 in 1908–9. The catalogues show that the number of students for 1907–8 was 440 and for 1908–9 445, thus showing a slight gain instead of a loss of 10 per cent.

A reference to the reports of the president of Cornell University proves that the statement made by me in the issue of December 24, 1909, to the effect that at Cornell the number of undergraduate women in the academic department is probably larger than that of the men is not borne out by the facts of the case. On page 18 of the president's report for 1908–9 the following statement appears: "This increase in attendance in the College of Arts and Sciences has taken place in spite of a slight decline in the number of women enrolling in that college. In 1907–8 there were 313 women and 507 men, in 1908–9 there were 309 women and 593 men." No distinction is made between men and women in the figures furnished for the table included in the number of SCIENCE to which reference has been made.

RUDOLF TOMBO, JR.

THE STRICT APPLICATION OF THE LAW OF PRIORITY TO GENERIC NAMES

MR. FRANK SPRINGER, on the first of May last, distributed to one thousand zoologists and paleontologists a circular bearing upon the question of the rigid application of the so-called "law of priority" in zoological (and paleontological) nomenclature. The generic name *Encrinus*, the best known and supposedly the most firmly established of all of the generic names of the Crinoidea—the name of the typical crinoid genus of all authors, both of learned systematic works and of general treatises and text-books, for over one hundred years—was shown to be untenable as previously understood, having been earlier employed (a use long since forgotten) for other and widely different genera, this application of necessity, if section 30 of the international code were rigidly followed, causing the preoccupation of other generic names equally well established. The case was still further complicated by the intricate technical problems in regard to the earlier usage of the name *Encrinus*, and the great zoological difficulties in the way of a positive identification of the earlier genotypes, altogether causing such confusion that the most expert taxonomists differ widely in their interpretation of the facts.

The circulars were distributed by the undersigned, except those destined for Norway, Sweden, Denmark and Germany; Dr. Th. Mortensen very kindly undertook the task of sending them to the naturalists in these countries, and for his courtesy in thus assisting us we take this opportunity of offering him our most sincere thanks.

A post card was enclosed with each circular, the recipient being requested to return it with the information whether, in his judgment, it would be better to retain the name *Encrinus in statu quo ante* (with the genotype *E. liliiformis* Lamarck) or to follow strictly the dictates of the code and overturn the heretofore universally accepted nomenclature of a large

and important group, a group which, above all others, is of prime importance to a very large number who can not, from the nature of their work, occupy themselves with laborious taxonomic research in a more or less alien field.

The reception accorded the circular was extremely gratifying, graphically demonstrating the deep interest taken in nomenclatorial questions not only by systematists, but by zoologists and paleontologists interested in all the varied phases of their subjects; to those who have so kindly acceded to our request and have acquainted us with their personal views we beg to tender our most cordial thanks.

Replies have been received from zoologists and paleontologists resident in the following countries: Algeria, Austria-Hungary, Brazil, Canada, Ceylon, Denmark, Egypt, England, Finland, France, Germany, Hawaii, Holland, Ireland, Italy, Jamaica, Japan, New South Wales, New Zealand, Norway, Philippine Islands, Portugal, Queensland, Russia, Scotland, South Australia, Sweden, Trinidad, United States, Western Australia and Victoria.

Of these working zoologists and paleontologists 80 per cent. are entirely dissatisfied with the present course of procedure; and this number is by no means inclusive merely of those having only an indirect interest in systematic work, but is made up to a surprising extent of the most prominent systematists; 83 per cent. are more or less dissatisfied with the methods now in vogue; about 18 per cent. believe it best to adhere to the code in its present form, and 15 per cent are convinced that this is the only logical and reasonable course.

The individual replies will, of course, be considered in the light of confidential communications, and therefore no indication will be given as to how any one has answered; when the canvass is concluded a minute analysis of it will be published, together with the names of those who have replied, showing the existing sentiment in the greatest detail for each class of workers, and for workers in the various groups, and a synopsis will be given of all the suggestions which have been sent in, with the proportionate numerical strength of each, each suggestion being duly and specifically accredited to its author or authors, who will have the opportunity of finally revising it before it is sent to press. It is our hope that this canvass now under way will result in the formulation of an amendment to, or a revision of, article 30, by which zoological nomenclature may attain a true stability and henceforth be freed from the constant and perplexing changes now abounding on every side.

We beg that all zoologists and paleontologists who read this notice and who have not yet sent in their decision will do so at once; and that they will favor us with an expression of their views in regard to the best means of attaining a more stable system of zoological and paleontological nomenclature than we have at present.

Owing to press of other duties, Mr. Springer will not be able to continue further the work which he has started; he has therefore requested me to take it up and carry it on to its conclusion, analyzing and preparing for publication the final results. In order that these may be as expressive as possible of the true sentiment of working zoologists and paleontologists as a whole, he joins with me in urging all interested in the subject of nomenclature, no matter in what branch of zoology or paleontology their interest may lie, to submit their opinions, whether for or against the present method of procedure, and to assist us in the formulation of a possible means of escape from the nomenclatorial difficulties which on every side beset the path of the modern naturalist.

AUSTIN H. CLARK
1726 EIGHTEENTH ST.,
WASHINGTON, D. C.

SCIENTIFIC BOOKS

A College Text-book of Geology. By T. C. CHAMBERLIN and R. D. SALISBURY. 8vo, xvii + 978 pp., illustrated. New York, Henry Holt and Company. 1909.

This book seems to be a concentrated form of the three-volume work on geology by the same authors and published by the same company, 1904–1906. Such a boiling down of one's results is usually a tedious process, and

the results are not always satisfactory either to authors or readers. In the present case, the results must be regarded as remarkably satisfactory, when looked at from the point of view of the common run of students. It is to be expected that the book will not satisfy the demands of everybody, but teachers of geology will agree that brevity has its advantages as well as its disadvantages. For example, the condensed statement of the three principal theories regarding the origin of the earth is the best we have seen, though it does not, of course, do away with the necessity of studying their fuller discussion elsewhere. The book is not, however, a simple condensation of the larger work, for the results have been gleaned and added from many papers published since the larger work came out.

In our opinion the authors have done well to lump dynamical and structural geology together and to treat it as a whole.

The chief faults that can be found with the work are matters of editing, and consequently are of no great importance.

The several maps showing the land and water areas at different periods have the rather annoying defect of lacking explanations of the conventional shadings. References are made, to be sure, to preceding cases, but inasmuch as such a book is seldom read consecutively, one finds it pretty tiresome to have to back up, as it were, from page 830 clear to page 445 to be sure that he is interpreting the conventionals properly.

Many of the effective illustrations of physiographic forms used in the larger works are given in this volume also. It seems unfortunate that some of the political boundaries that belong in the originals from which these extracts are taken have been left to mar these excellent illustrations. For example, in Plate XI., opposite page 172, are fragments of two such lines that are entirely meaningless in the plate. In Plate IX., opposite page 156, the international boundary might advantageously be omitted entirely, as it is already omitted in part. In Plate VIII., opposite page 133, the line down the middle of the stream in Fig. 1 might well be cut out. Opposite page 96, Plate I., Fig. 1, is another such line that is over conspicuous and meaningless as the illustration stands. Of course these lines in some instances serve some purpose, in others they do not. The work of cutting them out of the engraving is very little, even if they are not "stopped out" in making the plates.

At page 288 the shading of Fig. 186 to represent the land seems to have been overlooked. At page 240, Fig. 196, a photograph of the Fiescher glacier, is labeled "Aletsch glacier."

The larger work by these authors must long remain as a landmark in North American geology and the work of reference for all serious students and for all teachers and workers. But the "College Text-book" meets the larger demand of a larger number of readers both in our institutions of learning and outside of them.

The appearance of this new and important book again calls attention to the shortcomings of some of our best American publishers. When are we to have in this country a book on geology as well manufactured as Geikie's text-book? We have the geologists competent to prepare the text, but our publishers seem to be afraid that the cost of a really well-made book will shut it out of the market. We can not believe it. It is true that we have more text-books on geology than we need, but not more by such men as Chamberlin and Salisbury than we need.

J. C. BRANNER

STANFORD UNIVERSITY, CAL.,
December 10, 1909

A Revision of the Entelodontidæ. By O. A. PETERSON. Mem. Carn. Museum, Vol. IV., No. 3, 1909, pp. 41–146, with Pls. LIV.–LXII. and 80 text figures.

In this important memoir Mr. Peterson discusses at length the remarkable group of swine-like forms generally known as the Elotheres. In his introductory remarks, however, the author replaces the more familiar family name Elotheridæ Pomel by that of Entelodontidæ Amyard on the ground of inadequate description, no illustrations and loss of type by Pomel, though the name he proposed may have appeared first.

A careful revision of the family, genera and species follows in which are described as valid the genera *Entelodon* with two species; *Archæotherium* with four species and one subspecies—including those usually grouped under the genus *Elotherium;* the subgenus *Pelonax* including three species; *Dæodon,* two species; *Dinohyus,* one species, and *Ammodon,* one species. The forms known as *Elotherium imperator* and *Elotherium superbum* can not be generically determined.

A history of the discovery and working of the famous Agate Spring Quarry follows together with geologic notes and a diagram of the Miocene section.

In discussing the cause of the deposit at Agate Spring which has rendered up so abundant and wonderfully preserved a fauna, Mr. Peterson imagines the location to have been the favorite crossing place of a stream which at times contained engulfing quicksands. The remains are those of animals which attempted to cross at the unfavorable intervals.

A detailed description of that marvelous Suilline, *Dinohyus hollandi,* is next given—a brute of rhinocerine bulk. Two restorations are given of the skeleton, one of which is an actual photograph of the mounted specimen followed by that of a model showing the possible appearance of the animal in the flesh.

In conclusion Peterson tells us that the Entelodontidæ constituted a collateral branch of the Suidæ which diverged in early Eocene time. They are nearest the pig and hippopotamus among recent forms.

In geographical distribution they are found especially in Europe and North America, none as yet having been reported from Asia. They were comparatively abundant on the flanks of the Rocky Mountains and existed also in California and New Jersey. From the Lower Oligocene upward and before the close of the Miocene they occupied certain areas from the Pacific to the Atlantic coasts of North America.

Mr. Peterson's work shows painstaking care and thought and advances our knowledge of this interesting group very materially. It is especially valuable in the clearing up of synonymies and in defining the various valid types.

RICHARD S. LULL

YALE UNIVERSITY

The Cranial Anatomy of the Mail-cheeked Fishes. EDWARD PHELPS ALLIS, JR., in Zoologica (herausg. von Professor Dr. Carl Chun), H. 57, B. 22. Stuttgart. E. Schweizerbartsche Verlagsb. 1909. Quarto, 219 pages, 8 plates.

This is another example of the painstaking descriptive work for which zoology is so greatly indebted to Mr. Allis. The work is illustrated by splendid lithographic plates after drawings by the artist Nomura from special preparations. The greater part of the paper is devoted to the descriptive anatomy of the skeleton of the head, and its chief value lies in the attention to detail in the text and the accuracy with which the figures are executed. The morphology of the myodome and the criteria of segmental relations in the cranial nerves are discussed at some length. The myodome is believed to be the homologue of the cavernous and intercavernous sinuses of the human skull.

With regard to the segmental relations of cranial nerves, Allis states that "there is a marked tendency to consider the central origin of a given cranial nerve of much more importance for the determination of its segmental position than the course of the nerve and its general relations to the skeletal elements." This he attributes to the acceptance of the neurone theory, according to which nerve fibers follow always the path of least resistance to their destination. According to this conception the points of origin of nerve components in the central nervous system give the only positive criteria as to their segmental position, and their peripheral course is explained by accident, individual experience or elective selection. The author thinks this view unfortunate and not well founded.

The reviewer has never observed the tendency of which Mr. Allis speaks. On the contrary, the segmental position of a nerve is determined primarily on the basis of its periph-

eral course and distribution. The conclusions derived from these facts may be modified by the embryonic or the phylogenetic history, which may give evidence that the nerve has reached its observed adult position through secondary shifting or change of course. The point of view is illustrated in the recognition of the ophthalmicus profundus as a separate segmental nerve in spite of its central origin in common with the trigeminus in every vertebrate. Also, in the shifting of the roots of several cranial nerves from segment to segment. Also, in the analysis of the vagus into several segmental nerves because of its peripheral relations. Also, in the recognition of a general cutaneous component in each segmental nerve, including the facialis, although all these components are commingled in a non-segmental central nucleus. The statement made by Allis expresses a profound but not uncommon misconception of the attitude and method of students of nerve components. Without exception these workers would agree with Allis in attaching primary importance to the peripheral course and distribution of nerves, but they would not agree that this is in any way inconsistent with the neurone theory.

What has led Allis to the statement quoted above is the fact that communis fibers have not been recognized as a primary component of the trigeminus as a segmental nerve. He argues in substance as follows: in some fishes communis fibers are distributed by way of the rami of the trigeminus and, generally, cutaneous fibers run in the hyoideo-mandibular ramus of the facialis. In *Amia* and *Petromyzon* cutaneous fibers are present in the root of the facialis. Why should not both communis and cutaneous components be assigned to both trigeminus and facialis? Students of nerve components have assigned the communis fibers to the facialis and the cutaneous fibers to the trigeminus, except where they run in the *root* of the facialis, on phylogenetic grounds. In forms not provided with an operculum the cutaneous component in the hyoid segment is primitive and has its root and its ganglion cells in the facialis root and ganglion. In operculated forms (with the single exception of *Amia* so far as known) this cutaneous component in the facialis has disappeared and fibers from the trigeminus have secondarily invaded facialis territory to supply the operculum.

Similarly, in primitive forms no communis fibers have been found in the trigeminus. In fishes in which taste organs are present in the outer skin of the head, such fibers are distributed by way of the trigeminal rami, but they leave the brain in the facialis root and have their ganglion cells in the facialis ganglion. Their distribution is therefore secondary and they belong to the facialis segment. The same is true of the facialis root fibers which go to the fins, or even the tail, to supply taste buds.

It is one advantage of the neurone theory that such cases as this are explained without difficulty, while upon the Hensen hypothesis of primary continuity of nerve cell and end organ, it is inconceivable how taste organs in the skin should have secured a nerve supply at all, since the taste organs in primitive forms were wholly entodermal and the cutaneous nerves did not carry any fibers to innervate them.

J. B. JOHNSTON

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VII., No. 2, issued January 8, 1910, contains the following: "Effects of the Presence of Carbohydrates upon the Artificial Digestion of Casein," by N. E. Goldthwaite. The digestion of casein is retarded by the presence of carbohydrates. "The Quantitative Separation of Calcium and Magnesium in the Presence of Phosphates and Small Amounts of Iron Devised Especially for the Analysis of Foods, Urine and Feces," by Francis H. McCrudden. Description of a new method. "A Note on the Estimation of Total Sulphur in Urine," by Stanley R. Benedict. Criticism of Ritson's method. "The Fate of Sodium Benzoate in the Human Organism," by H. D. Dakin. Daily doses of 5 to 10 grams of sodium benzoate for two or three days are eliminated practically quantitatively in the urine as hippuric acid.

An improved method for estimating hippuric acid is described. "A Chemical and Bacteriological Study of Fresh Eggs," by M. E. Pennington. A series of comprehensive chemical analyses of whites and yolks of fresh eggs with the separation and study of the bacteria within them. Thirty-six species were isolated and identified. "Phlorhizin Glycocholia," by R. T. Woodyatt. Under the influence of phlorhizin, dextrose appears in the bile. "The Toxicity of Thallium Salts," by Robert E. Swain and W. G. Bateman. A study of the symptoms which are caused by thallium salts.

THE contents of *Terrestrial Magnetism and Atmospheric Electricity* for December, are as follows: "Exhibit of the Magnetic Work of the Carnegie Institution of Washington, December 13–18, 1909" (Frontispiece); "Some of the Problems of Ocean Magnetic Work," by L. A. Bauer; "Magnetic Storm of September 25, 1909, as Recorded at the Cheltenham Magnetic Observatory," by J. E. Burbank; "Letters to Editor"; "Biographical Sketch of Adolf Erman, 1806–1877"; "Portrait of Adolf Erman"; "Time and Direction at the Poles of the Earth," by W. J. Peters; "Notes"; "Abstracts and Reviews."

SUMMARIES OF SIX OPINIONS (9, 11, 13, 15, 17, 18) BY THE INTERNATIONAL COMMISSION ON ZOOLOGICAL NOMENCLATURE

THE following summaries of recent opinions by the International Commission on Zoological Nomenclature are published for the information of persons interested in the points in question. It is expected that the full details of the arguments will be published later in connection with certain other cases now under consideration. These summaries do not give the reservations made by certain commissioners, but these reservations will be presented in the final publication.

9. *The Use of the Name of a Composite Genus for a Component Part requiring a Name.*—The decision as to whether the name of a composite genus, when made up wholly of older genera, is tenable for a component part requiring a name, depends upon a variety of circumstances. There are circumstances under which such name may be used, others under which it may not be used. (Art. 32.)

Vote: Affirmative, 12; negative, 0; not voting, 3.

11. *The Designation of Genotypes by Latreille, 1810.*—The "Table des genres avec l'indication de l'espèce qui leur sert de type," in Latreille's (1810) "Considérations générales," should be accepted as designation of types of the genera in question. (Art. 32.)

Affirmative, 11; negative, 1; not voting, 3.

13. *The Specific Name of the Sand Crab.*—Catesby's (1743) prelinnæan name *arenarius* is not available under the code, although "reprinted" in 1771; *quadratus* 1793 is stated to be preoccupied; *albicans* 1802, being the next specific name in the list, becomes valid, under the premises submitted.

Affirmative, 10; negative, 0; not voting, 5.

15. *Craspedacusta sowerbii* Lankester, 1880, n. g., n. sp., vs. *Limnocodium victoria* Allman, 1880, n. g., n. sp.—*Craspedacusta sowerbii* Lankester, 1880, June 17, has clear priority over *Limnocodium victoria* Allman, 1880, June 24. Presentation of a paper before a scientific society does not constitute publication in the sense of the code. The commission is without authority to sanction usage in contravention to the provisions of the code.

Affirmative, 15; negative, 0.

17. *Shall the Genera of Weber, 1795, be Accepted?*—Weber's "Nomenclator entomologicus," 1795, complies with the requirements of Article 25, hence the genera in question are to be accepted, in so far as they individually comply with the conditions of the code.

Affirmative, 11; negative, 1; not voting, 3.

18. *The Type of Hydrus Schneider, 1799, 233.*—On the basis of the premises submitted by Dr. Stejneger, *Hydrus caspius* Schneider, syn. *Coluber hydrus* Pallas, is the type of Schneider's genus *Hydrus*, according to Article 30 (d). The fact that Schneider refers to the page and number of this species establishes the point in question and the fact that the name *Coluber hydrus* was not quoted is

perhaps unfortunate but not essential to decide the question at issue.

Affirmative, 13; negative, 0; not voting, 2.

C. W. STILES,
Secretary of Commission

THE MEXICAN COTTON BOLL WEEVIL

PROBABLY the control of no insect pest has involved greater difficulties than that of the cotton boll weevil. This enemy of a great staple crop works in such a manner that it has seemed beyond the usual means that have been followed in insect control. In all except the adult stage it is found within the fruit of the cotton plant. For the greater portion of its existence, therefore, it is at least as well protected as it would be if it occurred some distance below the surface of the soil. Even in the adult stage the insect has habits that tend to place it beyond the reach of man. As a consequence, investigations of the insect that have been carried on for several years have not revealed a great number of direct remedial measures. In fact, the destruction by burning of the left-over portion of the crop and the insects contained is the only direct means of importance that has been devised. It is gratifying to note that recent investigations by Mr. Wilmon Newell and Mr. G. D. Smith, of the Louisiana State Crop Pest Commission, published in Circular 33 of that commission, reveal another direct means of control that gives promise of general applicability. The work of Messrs. Newell and Smith is of considerable general interest, because it shows a successful outcome from continued investigation leading from a suggestion revealed in research. The investigators observed a clue pointing toward the possibility of control and directed all their energies toward the practical perfection of the idea.

For some years a cotton planter of considerable prominence has been advocating vigorously the use of paris green for the control of the boll weevil. Though well-meant, his campaign has been based upon a demonstrated fallacy. Extensive tests that have been made by various agencies have shown that the application of this poison is by no means a practical means of destroying the boll weevil. One of the agencies that tested the use of paris green was the Louisiana State Crop Pest Commission, of which Mr. Newell is the executive head. Although large and repeated applications did not result in increasing the yield of cotton in the experimental fields, it was evident, both in these tests and in cage experiments, that a number of weevils were killed. Instead of stopping at this point, Mr. Newell conceived the idea of determining wherein the paris green was ineffective and how its action might be increased. There were two important difficulties to overcome. In the first place, as paris green is now manufactured, a small portion of free arsenic causes burning of the foliage of plants. As the amount of the poison applied is increased, this damage, though insidious and at first scarcely noticed, becomes greater until it is very serious. On this account increasing the amount of paris green in the first experiments offered no hope as a practical remedy. The second obstacle encountered was the difficulty of forcing the poison into the portions of the plants where a considerable number of weevils would be likely to obtain it. The mechanical structure of the poisons in use prevented this. They were too coarse for effective work. To obviate the first difficulty, Mr. Newell determined to use arsenate of lead, which can be applied in very large amounts without any injury whatever to the foliage. The second difficulty was overcome by inducing a manufacturer to put up a special, finely powdered form of the poison. When this point was reached, a considerable series of field experiments was outlined. These experiments comprised about forty-six acres of cotton to which the poison was applied, as well as forty-nine acres provided as control areas. The treated cotton in these experiments produced an average of 71 per cent. more than similar cotton in the checks. In some cases the net profit was even startling. In one case a net profit of over $23 per acre was obtained.

A large portion of the effectiveness of the application of powdered arsenate of lead in the experiments was undoubtedly due to the thoroughness with which the work was done.

A special device, involving an air blast, was used to force the poison into the parts of the plant most frequented by the adult weevils. In the experiments described the application was made in person by the junior author, Mr. Smith, or under his personal supervision. It is possible, and in fact is forcefully pointed out in the report, that such successful results as those obtained in some of the experimental work should not be expected under the practical conditions on plantations. The writers even point out that it is likely that nine out of ten planters will fail to obtain satisfactory results from the first work they do. Nevertheless, every consideration seems to indicate clearly that powdered arsenate of lead can be used very profitably as an important adjunct in connection with the system of control that has been in use heretofore.

It is not extreme to state that the work accomplished with powdered arsenate of lead by Messrs. Newell and Smith marks an important advance in our knowledge of the control of the boll weevil. It promises in a short time more than to compensate the state of Louisiana for all the money that has been expended in the operations of the Crop Pest Commission since its establishment. W. D. Hunter

U. S. Department of Agriculture

SPECIAL ARTICLES

DOUBLE IMAGES OF AN OBJECT AS SEEN THROUGH A WATER SURFACE

In Science of November 29, 1901, the present writer discussed this subject as presented by Matthiessen.[1] It was there pointed out that Matthiessen's equations had all been deduced in a paper by the present writer, in 1881, in the *Transactions of the Academy of Science of St. Louis.*

Matthiessen urged that two images of an object are formed when it is viewed through a water surface. One lies upon the caustic of refraction, and is therefore above the level of the object, and nearer to the eye. The other is along the same line of sight, but on the normal through the object.

[1] *Ann. der Physik*, 1901, No. 10, S. 347.

In my paper of 1881 the latter image was discussed as the one actually seen.

It is evident that all rays from a point on an object thus viewed, will when produced backwards, not only be tangent to the caustic but will also cut the normal. Every ray of the cone of rays whose base is the pupil of the eye will thus appear to pass through an area on the surface generated by revolving the caustic around the normal. They will also intersect between two limiting points on the normal. The image of the point will therefore appear as distorted into an area on the caustic surface, and as a short line on the normal. My idea has always been that the former image was too indistinct to be visible.

Recently, while deducing the equation of the caustic, it occurred to me that the image might be seen upon the caustic surface, if the head were inclined so that the eyes were in the same vertical plane. The axes of the two cones of rays make then with each other an angle lying in the vertical plane, and the eyes may be focused on their point of intersection. The images on the caustic will then be practically superposed, and the line images on the normal will be more widely displaced on each other. The experimental result is very striking, and may easily be obtained by observing a chain, or the water-plug and chain at one end of a bath tub filled with water.

When both eyes are used, the water plug with the vertical chain, to which it is attached, appears projected towards the observer by a foot or more, if the eyes are near the surface and at the opposite end of the bath tub. If one eye be now closed, the image recedes to the vertical line through the object, appearing along the same line of sight as before. It therefore appears at a lower level.

When both eyes are in the same horizontal plane, the image is seen on the normal through the object. The images on the caustic surface as seen by the two eyes are then displaced on each other, and those on the normal coincide. Opening and closing one eye then produces no change in the position of the image.

Francis E. Nipher

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION A—MATHEMATICS AND ASTRONOMY

As the American Mathematical Society held its annual meeting in affiliation with the American Association the special program of Section A did not include any technical mathematical papers. The most striking features of the program of this section were the joint sessions with Section B and the American Mathematical Society. The fact that such eminent men took part in these sessions enhanced the interest and called more general attention to the need of closer relations between scientific bodies representing neighboring subjects. In particular, the need of frequent conference between the physicists and the mathematicians can not be too strongly emphasized in the present stage of our development, and it is to be hoped that the eminently successful joint session of Sections A and B will tend to spread and intensify the appreciation of this need.

The address of the retiring vice-president, Professor C. J. Keyser, of Columbia University, was given during the joint session of Section A and the American Mathematical Society, held on Wednesday morning, December 29. During the same session Professor D. E. Smith, of Teachers College, Columbia University, read his paper on the work of the "International Commission on the Teaching of Mathematics." Professor Smith is chairman of the United States section of this important commission, the other members appointed by the central body are, Professor W. F. Osgood, of Harvard University, and Professor J. W. A. Young, of Chicago University. The paper by Professor C. Runge, Kaiser Wilhelm exchange professor of mathematics at Columbia University for the present academic year, was read at the joint session of Sections A and B and the American Mathematical Society, held on Tuesday afternoon. At the same session Professor E. W. Brown read his first paper.

An interesting feature of the program was the visit to Harvard College Observatory on Monday afternoon at the close of a brief session of the section. The director of the observatory, Professor E. C. Pickering, invited Sections A and E to visit the observatory at this time and he explained to them photographs and illustrations of work in progress. In view of the fact that Percival Lowell failed to reach Boston before the close of the program of Section A his paper was transferred to Section B. All the papers of the following list, with the exception of the five mentioned above, were read at the three special sessions of Section A. These special sessions were held on Monday afternoon, Tuesday morning and Wednesday afternoon. The complete list of papers accepted for the program of Section A is as follows:

1. "The Thesis of Modern Logistic" (vice-presidential address), by C. J. Keyser.
2. "On the Determination of Latitude and Longitude in a Balloon," by C. Runge.
3. "On Certain Physical Hypotheses sufficient to explain an Anomaly in the Moon's Motion," by E. W. Brown.
4. "The Work of the International Commission on the Teaching of Mathematics," by D. E. Smith.
5. "The Value of the Solar Constant of Radiation," by C. G. Abbot.
6. "A New Mode of Measuring the Intensities of Spectral Lines," by F. W. Very.
7. "The Absorption of Light by the Ether of Space," by F. W. Very.
8. "The Fireball of October 7, 1909," by F. W. Very.
9. "On a Recent Hypothesis and the Motion of the Perihelion of Mercury," by E. W. Brown.
10. "The Heliocentric Position of Certain Coronal Streams," by J. A. Miller and W. R. Marriott.
11. "The Mutual Relation of Magnifying Power, Illumination, Aperture and Definition in Telescopic Work," by David P. Todd.
12. "La Contribution Non-euclidienne à la Philosophie," by G. B. Halsted.
13. "Declination of the Moon for Greenwich Mean Time," by D. H. E. Wetherill.
14. "Meteorological Waves of Short Period and Allied Solar Phenomena," by H. W. Clough.
15. "Recent Work with the 6-inch Transit Circle of the United States Naval Observatory," by Milton Updegraff.
16. "The Canali Novæ of Mars," by Percival Lowell.
17. "Peculiar Star Spectra indicating Selective Absorption of Light in Space," by V. M. Slipher.
18. "Personality with the Transit Micrometer," by R. M. Stewart.
19. "Water Vapor on Mars," by Frank W. Very.
20. "The Existence of Anomalous Fluctuations in the Latitude as shown by Simultaneous Observations with the Zenith Telescope and the

Reflex Zenith Tube of the Flower Observatory," by C. L. Doolittle.

21. "Visual Observations of Variable Stars at the Harvard College Observatory," by Leon Campbell.

Professor Keyser's vice-presidential address appeared in full in the December 31 number of SCIENCE. In the absence of their respective authors the paper by Professor Todd and those of Messrs. Wetherill and Slipher were read by title, while that of Mr. Stewart was presented by Dr. O. J. Klotz, Ottawa, Canada. The abstracts which follow bear the same numbers as the corresponding titles in the preceding list.

2. The problem of finding your geographical position in a balloon from observations of the sun is very different from the same problem on board ship, for this reason, that in a balloon there is no dead reckoning. The method used on board ship of observing two altitudes of the sun at two different hours of the day can not be applied, for the two Sumner lines have to be shifted so as to correspond to the same moment and this can only be done by dead reckoning. In a balloon, therefore, the only way of getting your geographical position from the sun is by observing both altitude and azimuth at the same time. Now the accuracy with which the azimuth of the sun may be observed is rather small; it would be difficult to obtain it within less than one tenth of a degree. Therefore the reduction of the observations need not be very accurate, either. At the same time it is essential that the reduction should be made very quickly. For the time since the moment the observations were taken introduces an uncertainty that may be expressed by the area of a circle whose radius is equal to the distance through which the balloon may have traveled. One naturally would therefore turn to graphical methods for the reduction of the observations. The reduction consists in finding the latitude ϕ and the hour angle t from the declination δ, the azimuth a and the altitude h. Professor Runge proposes to find first the latitude ϕ from δ, a, h and then the hour angle t, from δ, a, ϕ. In both cases we have to deal with the representation of an equation between four variables. Both of these equations may be written in the following form:

$$f(p) + h(r, s)g(q) = k(r, s)$$

where p, q, r, s denote the four variables. That is to say, two of the variables enter the equations in functions of their own $f(p)$, $g(q)$ and the equation is linear in these functions, the coefficients being any functions of the other two variables. Equations of this kind may be represented graphically by the "méthode des points alignés" of Maurice d'Ocagne[1] taking $f(p)$ and $g(q)$ as line coordinates. I propose making $f(p)$ equal to the ordinate of the point of intersection of the straight line with the axis of ordinates and $g(q)$ equal to the gradient of the straight line, that is, the tangent of its angle with the axis of abscissa. In that way the rectangular coordinates of the point whose equation in line coordinates is the given equation, become:

$$x = h(r, s) \text{ and } y = k(r, s).$$

For any given value of p, the different values of q correspond to straight lines that form a pencil of rays, whose center is on the axis of ordinates at the particular value defined by p, and any alteration of p would simply shift the center along the axis without altering the pencil of rays in any other way. The whole diagram may therefore be obtained by drawing two figures, one containing the curves $r = \text{const}$ and $s = \text{const}$, the other containing the pencil of rays, and placing these two figures in the proper way, one over the other. It so happens in our cases that the variable p is the declination of the sun, which during the ascent of a balloon may be regarded as constant. The aeronaut would therefore merely use a definite superposition of the figures. They are photographed on transparent plates and a blue print is taken by copying the plates one after another on the same paper in the proper position. The aeronaut has one blue print to read off the latitude and a second one to read off the hour angle after he has found the latitude. The equations are:

$$(1) \quad \sin\delta + \cos\phi\cos h\cos a = \sin\phi\sin h,$$
$$(2) \quad \tan\delta + \sec\phi\sin t\cot a = \tan\phi\cos t.$$

In the first equation the curves $\phi = \text{const}$ and $h = \text{const}$ are the ellipses

$$x = \cos\phi\cos h, \qquad y = \sin\phi\sin h.$$

In the second equation the curves $\phi = \text{const}$ and $t = \text{const}$ are the confocal ellipses and hyperbolas

$$x = \sec\phi\sin t, \qquad y = \tan\phi\cos t.$$

3. Newcomb has shown that there is a difference between the observed and the theoretical positions of the moon which can be roughly represented by a term of period about 270 years and coefficient 13″. In this paper Professor Brown

[1] Maurice d'Ocagne, "Traité de Nomagraphie."

examined numerous hypotheses sufficient to explain the term, in order to clear the ground of those which seemed to be of doubtful value and to bring forward those which appeared sufficiently reasonable to merit tests from observations of a different nature. Some account of three of these hypotheses was presented to the meeting. It was stated that a minute libration of the moon would be sufficient, provided it took place in the moon's equator and had the proper period. The supposition of magnetic attraction practically demanded (*a*) a periodic change in the magnetic movement of the earth or of the moon. If (*a*) were rejected, it was necessary to suppose that the mean place of the lunar magnetic axis was near the lunar equator and that the oscillations of its position took place in the plane of the equator. The observed secular change of the earth's magnetic axis could not produce the phenomenon without demanding a larger motion of the lunar perigee than observation warrants. On the border line between two sets of hypotheses was a curious fact, namely, that if the period of the solar rotation coincided very nearly with one of the principal lunar periods a minute equatorial ellipticity of the sun's mass was sufficient to explain the term. So far as known, these hypotheses do not conflict with any observed phenomena but they cause some theoretical difficulties.

4. The International Commission on the Teaching of Mathematics was suggested some years ago, but the first steps in its organization were not taken until April, 1908. At that time the Fourth International Congress of Mathematicians, then in session in Rome, empowered Professor Klein, of Göttingen, Sir George Greenhill, of London, and Professor Fehr, of Geneva, to appoint such a commission, and to arrange for it to report at the next congress, to be held at Cambridge in 1912. As a result, three commissioners have been selected from each of the leading countries and the work has actively begun. It is expected that each of these countries will submit a very full report of the nature of the work in mathematics, from the kindergarten through the college, with some discussion of the range of advanced work in the universities. In the United States the investigation is carried on by means of fifteen committees, each divided into subcommittees. About two hundred and seventy-five people are engaged in the work and the subcommittee reports will be submitted during the present winter. The committee reports will be submitted before the summer of 1910, and the national report by Easter, 1911.

5. Since 1902 the staff of the Smithsonian Astrophysical Observatory has been engaged in bolometric measurements of solar radiation to determine the "solar constant," and to note possible variations of solar emission. The measurements have been conducted at Washington (sea level), at Mt. Wilson (one mile) and at Mt. Whitney (nearly three miles). When corrected for atmospheric losses by employing Bougner's transmission formula, and reduced to mean solar distance, the average results outside the atmosphere agree within 2 per cent. On good days at Mt. Wilson or Mt. Whitney the results have a probable error of about .5 per cent. By the construction and trial of three copies of a standard pyrheliometer of new design, in which the solar heating is continuously removed by water flowing about the walls of the hollow receiving chamber, and in which the accuracy of the measurements is checked by introducing known amounts of heat electrically in test experiments, the solar constant may now be expressed absolutely in calories per square centimeter per minute. Definitive reductions are not yet quite complete, but the final solar constant value will not differ 2 per cent. from 1.97 calories per square centimeter per minute. Variations of the solar emission of several per cent. from the mean value appear not to be uncommon, but during the continuance of the Mt. Wilson observations, prolonged periods of differences of 10 per cent. from the mean value, such as were suspected in 1903, have not been observed.

6. The method described by Professor Very consists in matching the two halves of a bright line, seen projected upon a uniformly illuminated background. One half of the line (it may be either the upper or the lower half at will) is a bright line or band in a photographic negative of a spectrum crossed by dark absorption lines, or in a positive of a bright-line spectrum. The other half of the line may be, if desired, a line in another spectrum, selected for its general similarity; but the best object for comparison is a slit over an illuminated ground-glass screen with means for the following adjustments: (1) The slit can be varied in width by a micrometer-screw. (2) The illumination of the ground glass can be varied by an optical device employing an iris-diaphragm. (3) The half of the field in which the image of the slit lies can be made to duplicate the other half by altering the illumination of the slit-jaws.

7. Professor Very believes that attempts to deduce a law of extinction of light in space, based

on the relative paucity of stars of the higher orders of magnitude, are probably illusory. The rate of extinction is small, and is marked by peculiarities of stellar distribution of a larger order. The evidence of a selective absorption or scattering of light, deduced by Kapteyn, appears to be real, but it is of local origin, and some new criterion is desirable.

An examination of the distribution, size and appearance of the nebulæ shows results which are in harmony with the supposition of an absorption of light by the ether of space. An attempt is made to deduce the distances of some of these objects; and the bearing on the problem of light-extinction furnished by such facts as can be learned from the nebulæ is discussed, together with the related questions of the knowable dimensions of the universe, and its coordination into a whole by means of a conservation of energy through ethereal and material interchange. The conclusion is reached that there is an absorption of radiation by the ether of space, and that a considerable fraction of the energy of the universe resides in the interstellar medium.

8. At $6^h 42^m$ in the evening citizens of Norwood, Mass., witnessed the fall of a brilliant orange-red fire ball which descended in a nearly vertical direction from an altitude of about 60° to the horizon, giving off laterally numerous white sparklets. The visible evidence of any explosions was lacking, and no sounds whatever accompanied the fall, which, according to the best observation, lasted about seven seconds. From internal evidence, it appears probable that the upper part of the path was seen almost end-on, and that the bolide may have reached the ground at no great distance. The claim that such was the case, and the asserted finding of a large and unique aerolite, were considered by Professor Very. Microscopic analysis shows that the stone is peculiar, and in spite of some doubtful points in the evidence, it is deemed best to put this evidence on record.

9. Professor Brown's second communication consists of a brief account of the hypotheses of Seeliger brought forward to account for the outstanding large residual in the motion of the perihelion of Mercury and the small residuals in the secular motions of the four minor planets. An analysis of the nature of the three hypotheses and a comparison of the number of arbitrary constants introduced with the number of residuals to be accounted for were also given.

10. Assuming that the theoretical corona is caused by light emitted by and reflected from streams of matter ejected from the sun by forces which in general act along lines normal to the sun's surface; that these streams are formed of a series of particles ejected from the same point of the sun's surface in such a way as to make a continuous stream, Professor Miller showed[2] that the curvature of these streams was due to mechanical causes, and that under certain conditions one could find the heliocentric position of these streams.

During the summer of 1909, Professor Miller examined and measured, at the suggestion of Director Campbell, the series of large-scale photographs of the solar corona made by him and other members of the staff of Lick Observatory, with a view of applying this theory to them. In all, there are sixteen streamers of this particular type recorded on these plates. Professors Miller and Marriott have since reduced the measures made during the summer. All the streamers measured have been reduced; there are two of them that can not be reduced according to this hypothesis. The others gave consistent and reasonable results. The purpose of the investigation was to locate, heliocentrically, these streamers. An interesting and striking by-product is, that under these hypotheses it is proved that these streamers can not assume the shape shown on the photographs unless they are acted upon, in addition to the attractive force of the sun, by a repulsive force of some kind, the magnitude of which can be determined.

11. Professor Todd's paper relates to experiments with the eighteen-inch Clark refractor at Amherst. They show the great improvement in definition of sun and moon, and the brighter planets and stars by simple reduction of the aperture to suit atmospheric conditions. Higher magnifying powers are thereby possible when the seeing is inferior, providing the illumination of the object allows. Variation of aperture from three to eighteen inches is effected by an iris diaphragm outside the objective.

12. This memoir gives the original meaning and the growth of meaning of non-Euclidean geometry, sketches its history and its founders, and points out that philosophy has found in non-Euclidean geometry a new criterion fusing into components of a new life the preexistent forms of Plato, forms of sensitivity of Kant, products of sensation of Locke, contributions of experience of Comte. Efficient science now finds trivial the old hypothesis of the importance of individual suffering, and the

[2] *Astrophysical Journal*, Vol. XXVII., No. 4.

new evasion that pain does not hurt—finds them as unnecessary as the parallel postulate.

13. For purposes of navigation, in checking the longitude, Mr. Wetherill proposes that the moon be observed in meridian altitude, and with the known latitude, the declination be interpolated in the "Nautical Almanac" for G. T. Where the change of declination is rapid per minute of time a good check can be made without the complication to the seaman of the calculation of the lunar distance.

14. Mr. Clough's study of meteorological and solar variations of short period discloses cyclical variations in the length of the period similar to those shown in 1904 to be characteristic of the 11-year and 36-year periods. The 3¼-year variation in the frequency of prominence and other solar phenomena, and the barometric pressure over Iceland and the Azores, ranges in length from about 2½ years in 1875 to 3¾ to 4 years in 1860 and 1893, showing a 36-year variation in the length of the period. The mean latitude of the entire spotted area is farthest north about eight months previous to the occurrence of a maximum phase of the pressure wave over Iceland. A 3-month period is shown to exist in spot and prominence frequency and also in the Iceland pressures, with variations in the length of the period conforming to variations in solar activity in the 3¼-year cycle, *i. e.*, the greater the activity the shorter the period. Two shorter periods of about 33 days and 10 days have been detected in meteorological phenomena, both of which undergo variations in length through a 3-month cycle.

The 3¼-year wave of pressure recedes from the Iceland Low to the Azores High in fourteen months, while the 3-month wave traverses the same distance in forty days. The 10-day wave, however, moves eastward around the globe, a continuous series of these waves having been traced over the United States during the past three years. This fact has an important bearing on recent measurements of the intensity of solar radiation at Washington and Mt. Wilson, the atmospheric transmissibility being apparently greater at the minimum phase of the 10-day temperature wave than at the opposite phase.

15. Professor Updegraff gave an account of the progress made during the past year in fundamental observations of the sun and fixed stars with the six-inch transit circle of the U. S. Naval Observatory in conformity with the plan for fundamental work adopted by the observatory council and approved by the superintendent.

The repairs made necessary by deterioration and the alterations of the instrument having been completed, the instrument was mounted in January, 1909, and observations of stars were commenced on January 31.

The form of the pivots and the stability of the rotation axis of the instrument have been thoroughly investigated and have been found to be highly satisfactory. The instrumental constants are remarkably stable and are determined with a satisfactory degree of accuracy, the probable error of a determination of the azimuth from the marks being $\pm 0^s.006$, of the level from the spirit level $\pm 0^s.006$ and of the collimation from the collimators, $\pm 0^s.006$.

The transit micrometer has been brought into use, and after practise the accidental errors of the observers are no larger than is the case with the chronograph key, which confirms the results reported by other observers using that form of instrument elsewhere in this country and in Europe.

The flexures of the telescope tube and the circles have been partially investigated and have been found to be small, the circles having no appreciable flexure. A preliminary investigation of the division errors of circle A has been completed and the results are being used in reducing observations in declination.

A series of observations by Mr. Hammond of stars direct and reflected has been reduced and a small difference reflected minus direct has been found which gives on discussion a value of the horizontal flexure the same as that obtained from observations on the collimators.

Satisfactory rates are given by the clocks in the clock vault. The clocks are not, however, in perfect order, as the bell jars leak somewhat, but all difficulties seem to have been overcome in regulating the temperature of the vault, which is kept constant within a few hundredths of a degree Centigrade for months at a time.

More than 3,500 observations of stars have been made in conformity with the plan for fundamental work mentioned above. The main features of this plan for fundamental work are as follows:

The clock rate is determined fundamentally by observation of the same clock stars by the same observer at consecutive transits.

The azimuth of the marks is determined by observations of circumpolar stars at consecutive transits U. C. and L. C.

The latitude for the reduction of observations

in declination is determined by observations of circumpolar stars at consecutive transits U. C. and L. C.

The sun and brighter stars are to be observed daily in both right ascension and declination, and the refraction by day and by night at all zenith distances is to be separately investigated and determined.

Systematic observations are being made in both right ascension and declination of lists about an hour long in right ascension of circumpolar stars, culminating between five and seven o'clock P.M. apparent local time, and of the same lists between the same hours in the morning at consecutive culminations as far as possible. These observations are made for fundamental places of the stars themselves and for the determination of the latitude and azimuth of the instrument and marks and of the atmospheric refraction. The advantages of observations of this kind are explained in SCIENCE, Vol. XXV., p. 689.

A group of nine fundamental stars near the vernal equinox has been selected for use as the fundamental standards in right ascension. They are being observed in connection with another group of stars near the autumnal equinox and are to be connected with stars at all right ascensions with a view to detect and determine systematic errors in right ascension. This requires the observation of stars more than twelve hours apart in right ascension on the same day by the same observer, and the work is combined with the observations of circumpolar stars described above.

16. On September 30, 1909, certain new canals were observed on Mars at the Lowell Observatory which proved to have an important history. The discovery of new canals on Mars, *i. e.*, some never before seen, is nothing new, as some four hundred have been detected there in the last fifteen years. The present canals were remarkable in being not only new to earth but new to Mars. This was proved by reference to the records kept of the observatory's observations since 1894. Not only had they never been recorded before, but examination showed that they were not due to any of the several causes which have been found there to affect the visibility of the canals, to wit: seasonal change, austral or boreal development, etc. They had therefore never existed previously but had just been formed. The importance of this discovery needs no comment, except that it was only made possible by the systematic, continuous research of fifteen years.

17. In the course of radial velocity work at Flagstaff, spectra of numerous stars in Scorpio, in Perseus and in Orion have been found to contain peculiarly sharp *H* and *K* calcium lines, which by their character and behavior seem to originate in inter-stellar space, according to Mr. Slipher.

18. At the Dominion Observatory, Ottawa, personal equation with the registering micrometer has been found to be not a negligible quantity. The paper by Mr. Stewart deals with the observations of 1908, giving the relative personal equations of the five observers engaged, and describing a short investigation into the causes underlying the phenomenon. In the case of the author there was found a tendency to set the movable wire always to the left of the star by a quantity in the neighborhood of a second of arc, depending on the magnitude; north stars at upper culmination would thus be observed too soon, others too late.

19. Apparent discrepancies in Professor Very's measures of the Lowell Observatory spectrograms of Mars and the moon, on which Professor Campbell has commented, are explained as due to the mode of reduction. In spite of minor variations, the mean readings for five plates gave for the extra intensification of little *a* in Mars in conventional units, a value nine times as great as the probable error. No greater accuracy than this is claimed, but the existence of water vapor in the atmosphere of Mars is believed to be demonstrated. The result is made possible by the superiority of Dr. Slipher's spectrograms.

Campbell's claim that Professor Very's result is due to a notable increase of *telluric* "*a*" which happened to coincide with the taking of the Mars spectrogram on *each* of five dates, is examined and rejected.

20. Simultaneous observations have been carried on with the two instruments mentioned in the title for the past five years; those for 1905–8 are available for this comparison, embracing 931 determinations. Confining our attention for the present to the larger deviations, we find the following results for the two instruments:

Both residuals 4 times the probable error, 2 (both like signs).

Both residuals 3 times the probable error, 9 (like signs, 8; unlike, 1).

Both residuals 2 times the probable error, 75 (like signs, 50; unlike, 25).

The preponderance of like signs seems to leave little doubt that anomalous fluctuations of very appreciable magnitude do occasionally take place.

21. Mr. Campbell gave a résumé of the visual

work on long-period variables begun at the observatory in 1889, when the list numbered seventeen stars, to the present time, when the list contains over three hundred; showing the progress that has been made in the methods of observing them.

The following members of Section A were elected as fellows: R. P. Baker, S. G. Barton, W. E. Brooke, Thos. Buck, Arthur Crathorne, R. T. Crawford, I. M. DeLong, C. E. Dimick, F. J. Dohmen, J. F. Downey, L. P. Eisenhart, J. C. Fields, B. F. Finkel, F. L. Griffin, A. G. Hall, C. N. Haskins, T. M. Holgate, J. I. Hutchinson, D. N. Lehmer, O. M. Leland, Wm. D. MacMillan, W. R. Marriott, C. N. Noble, J. A. Parkhurst, F. W. Reed, F. G. Reynolds, Charlotte A. Scott, A. W. Smith, R. M. Stewart, Joseph Swain. The section elected G. B. Halsted member of the council, E. R. Smith member of the sectional committee and H. W. Tyler member of the general committee. On recommendation of the sectional committee Professor E. H. Moore, Chicago University, was elected chairman of the section.

G. A. MILLER,
Secretary of Section A
UNIVERSITY OF ILLINOIS

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

THE 438th regular meeting of the society, held December 21, 1909, was devoted to a paper by Dr. I. M. Casanowicz on "The Alexander Legends in the Talmud and Midrash, with reference to Parallels in Greek and Assyrian Literature."

The passages in the rabbinical literature bearing on Alexander the Great may be divided into two sections: (1) those which refer to his relation to the Jews; (2) those which contain episodes of his expeditions and adventures.

The first part includes: (1) Alexander's meeting with the Jewish high priest. At the instigation of the Samaritans Alexander ordered the temple of Jerusalem to be destroyed; but being met by a procession of Jerusalem nobles, headed by the high priest, in whom he recognized the apparition which had walked before him in his victorious campaigns, he revoked the order and delivered the Samaritans into the power of the Jews. (2) The suits brought by several nations against the Jews before Alexander. The Canaanites brought action for the possession of the land of Canaan, as it admittedly was originally their fathers'. They were answered that as Canaan was the servant of Shem he and his possessions were the property of his master. The Egyptians claimed back the gold and silver of which the Israelites despoiled them at the exodus. They were met by the counter claim of the wages for the service of the Israelites for four hundred and thirty years.

The second part embraces the following episodes: (1) Alexander's dialogue with the sages of the South. He addressed to them ten questions on cosmogonic and moral subjects, as: What was created first? Who is to be called wise? Who strong? Who rich? etc. (2) Alexander's penetrating into the land of the Amazons. They ward off his attack by suggesting to him that there will be little glory for him if he killed them, being women, but that he will make himself eternally ridiculous should he be killed by them. (3) Alexander's visit to Qaçia. There he witnesses a suit before the king in which both litigants disclaim the ownership of a treasure. The king advises them to marry their children and give them the find. Alexander said he would have put the litigants to death and confiscated the treasure. The king of Qaçia declared that if rain falls and the sun shines in Alexander's country it must be on account of the animals, for the men did not deserve these boons. (4) Alexander's experience at the gates of Paradise. He was there refused admission but given as a token a ball. He weighed against it all his gold and silver, but could not counterbalance it. The rabbis put a little dust upon the ball and the scale in which it was immediately went up. They explained to him that it was the eyeball of a man who was never satisfied. (5) Alexander's ascent into the air. He rose up in the air until the world appeared to him like a bowl and the sea like a chalice. (6) Alexander's descent into the depth of the sea. He caused some of his men to dive into the ocean in glass chests. When returned to the surface they reported to have heard the ocean sing: "The Lord is mighty on high."

Most of these narratives are also found in the Greek compilation of the Alexander legends known by the name of Pseudo-Callisthenes, where they are embellished with many accessory details and otherwise much modified. The episodes of Alexander's adventure at the gates of Paradise or, as in the Greek account, the fountain of life, and his ascent into the air also suggest parallels in the Assyro-Babylonian literature; the first in the Nimrod Epic, the second in the Etana legends. There is a great resemblance between the rab-

binical and Greek accounts, pointing to a relationship between both. But the points of contact between the Assyro-Babylonian account, on the one hand, and the stories in Pseudo-Callisthenes and the Talmud on the other, are too vague and of a too general character to warrant the assumption of a direct relationship between them.

AT the 439th meeting, January 4, 1910, Dr. Aleš Hrdlička, of the National Museum, exhibited a cast of the lower jaw of *Homo heidelbergensis* donated recently to the National Museum by Professor Schoettensack, of Heidelberg University. This jaw, which is preserved at the university and has been described in detail by Professor Schoettensack, was found less than two years ago near the village of Mauer, 10 kilometers southeast of Heidelberg, under nearly 75 feet of loess and ancient river sand. It dates from the Upper Pliocene or the very beginning of the Quaternary period and represents the most ancient being known that can be regarded as man. To illustrate the remarkable characteristics of this jaw Dr. Hrdlička showed a number of mandibula of different anthropoid apes along with those of recent man. The paper was discussed by Messrs. Theodore Gill, G. M. Kober, D. S. Lamb, Daniel Folkmar and others.

The remainder of the evening was devoted to an address by Dr. W J McGee, on "Conservation in the Human Realm." The speaker said that the human realm may best be defined in terms of relation to the other great realms in nature; and these are most conveniently stated in the order of increasing complexity, which may be considered also the order of sequence in cosmic development.

The initial realm is that pertaining to cosmic bodies and their interrelations; the fundamental principle comprises the actions and reactions of gravity, impact, etc., which together have been denoted molarity; the field is largely covered by astronomy, with a part of physics. The second realm pertains to atomic and certain molecular interrelations; its fundamental principle is affinity; and its field coincides fairly with chemistry. The third realm is that of organic activity; its principle is vitality, which directly and indirectly accelerated and multiplied the chemical differentiation of the earth-crust; its field is covered by a large part of biology, with cognate sciences. The fourth realm (which is closely allied to the preceding) pertains to those organisms so complete in themselves as to be self-active; its principle is motility; and its field is covered by zoology and allied branches of knowledge. The final realm is that in which motile organisms are so completely self-active as to react upon and dominate lower nature; its principle is mentality; and its field is anthropology in all of those aspects resting on a psychic basis. Now the entities proper to the several realms coexist and interact; and in general the entities of each higher realm dominate over all those of the lower realms. This is especially true of mentality, which employs motility and directs vitality to control affinity and molarity, thereby making conquest over lower nature for human welfare. In the power of mentality human strength lies, while danger also lurks; for the power may be, and in the absence of constraint often is, used for the destruction rather than mere subjection of the materials and forces of nature. Viewed broadly, the exercise of control over the realms of lower nature pertains to the human realm no less than do the more passive attributes of mankind.

When this nation was founded but two resources were recognized—the men, with the land they made their home. Half a century later coal mining and the practical manufacture of iron began, and in another half century the industrial exploitation of the forests. Yet statecraft lagged behind industry so far that these enormous values below and above the surface were alienated nominally as land, passed under monopolistic control, and were diverted from the whole people to which they rightfully belonged; while free citizenship largely gave place to industrial dependence. At first water was neglected as a mere appurtenance to land; and now that it is recognized as the primary resource—that on which life depends, so that it gives value to all the rest—it also is passing under a monopolistic control whereby all citizenship will tend to merge into industrial dependence on centralized power. The situation is one of the gravest ever confronted by any people in the world's history, graver than any ever survived by a nation; and it behooves those possessing the advantage of scientific training and knowledge of principles to give it earnest consideration—and to aid in defining the interrelated duties of the individual, the family and the state in ways tending toward the perpetuity of our people.

A lengthy discussion of this paper closed the meeting.

JOHN R. SWANTON,
Secretary

SCIENCE

Friday, February 4, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

SOME CHEMISTRY OF LIGHT[1]

From the dawn of history, chemistry has had much to do with the production of artificial light, and I wish now to recall to your minds a few illustrations. I will not burden your ears with a long story on physics or mechanics of light, but intend treating the subject of artificial light so as to show you that it has always been largely a subject for chemical investigation. I want to impress upon your minds that it is still a most green and fertile field for the chemist. I have tried to arrange a few familiar experiments to illustrate some of the facts touched upon, and it should be borne in mind that I am trying to interest an audience of chemists from widely different fields, rather than to present a chronological record of recent experimental research.

I can not tell just when chemistry was first scientifically applied to a study of artificial light. Most cardinal discoveries are made by accident and observation. The first artificial light was not made by design nor was the first improvement the result of chemical analysis. It is supposed that the first lamps were made from the skulls of animals, in which oil was burned. Herodotus, describing events about three centuries before Christ, says of the Egyptians:

> At the times when they gather together at the city of Sais for their sacrifices, on a certain night they all kindle lamps many in number in the open air round about the houses: now the lamps are saucers full of salt and oil mixed and the wick

[1] Presidential address delivered at the Boston meeting of the American Chemical Society, December 29, 1909.

floats of itself on the surface and this burns during the whole night.

This night was observed all over Egypt by the general lighting of lamps, and these lamps were probably the forerunners of the well-known Greek and Roman lamps of clay and of metal which are so common in our museums.

The candle and lamp were probably invented very much earlier. We know that both lamps and candles were used by the priests of the Jewish temple as early as 900 B.C. The light of those candles and lamps was due, as you know, to particles of carbon heated in a burning gas.

It is not fair to the chemists of our early candle-light to skip the fact that great chemical advances were made while candles were the source of light, and so I touch for a moment upon one of the early applications of chemical knowledge. The fats and waxes first used were greasy and the light was smoky and dull. They were capable of improvement and so the following chemical processes were developed and applied to the fats. They were first treated with lime, to separate the glycerol and produce a calcium soap. This was then treated with sulphuric acid, and the free stearic and palmitic acids separated. These acids were then made into candles and gave a much whiter light than those containing the glycerol ester previously used. Similar applications of chemical principles are probably known to you all in the refining of petroleum. The crude distillate from the rock oil is agitated with sulphuric acid and then washed with a solution of sodium hydroxide. This fact accounts, in considerable degree, for the advance of a number of other chemical processes. An oil refinery usually required the presence of a sulphuric-acid plant in the immediate vicinity, and this often became a source of supply for other new chemical industries.

Very great advances have been made in the use of fats and oils for lighting purposes, but there is so much of greater interest in later discoveries that we will not consider many of them. The distillation of gas from coal or wood in 1739 was a chemical triumph, and a visit to a gas plant still forms one of the main attractions to the young chemist in an elementary course of applied chemistry. The first municipal gas plant was established in London, just about one hundred years ago. The general plan, so apparently simple to us to-day, was at its inception judged impracticable by engineers. In spite of other methods of illumination, the improvements in the making, purification and application of illuminating gas have caused a steady increase in its use. Gas owes its illuminating power to the fact that a part of the carbon in it is heated to incandescence during the combustion of the gas. It must contain, therefore, such carbon compounds as yield a fair excess of carbon, and this knowledge has led to the schemes for the enrichment of gas and for the use of non-luminous water-gas as a base for illuminating gas.

Various schemes were devised in the early part of the nineteenth century for using gas to heat to incandescence, rods or surfaces of lime, zirconia and platinum. This was not at first very successful, owing to imperfect combustion of the gas. The discovery of the Bunsen-burner principle was made a little later. By thus giving a much higher temperature to the gas flame and insuring complete combustion, new impetus was given to this branch, and the development of suitably supported oxide mantles continued for half a century.

Most prominent in this field is the work of Auer von Welsbach. It was a wonderful series of experiments which put the group of rare earth oxides into practical use and started a line of investigation

which is still going on. The Welsbach mantle practically substitutes for the carbon of the simple gas flame another solid in a finely divided shape capable of giving more efficient light. This allows all of the carbon of the gas to contribute to the production of a hotter flame. But more interesting than the mechanical success, to my mind, is the unforeseen or scientifically unexpected discovery of the effect of chemical composition. By experiment it was discovered that the intensity and color of the various mixtures of difficultly fusible oxides at incandescence varied over a wide range. Thus a broad field for unforeseen investigation was opened. The samples of Welsbach mantles which you see before you were kindly loaned to me by Mr. H. S. Miner, of the Welsbach Company, and beautifully illustrate the application of advanced chemical work to this industry. The color and intensity of the light vary in an unexplained manner with slight differences in composition of the mantle. The following are the composition and candle powers of the mantles shown:

CANDLE POWER OF MANTLES, RANGING FROM PURE THORIA TO 10 PER CENT. CERIA

No.	Per Cent. Thoria	Per Cent. Ceria	Candle Power
367	100.00	0.00	7
368	99.75	0.25	56
369	99.50	0.50	77
370	99.25	0.75	85
371	99.00	1.00	88
372	98.50	1.50	79
373	98.00	2.00	75
374	97.00	3.00	65
375	95.00	5.00	44
376	90.00	10.00	20
69	La, Zr, Ce Oxides,		30

The methods of making present mantles were also a part of Dr. Auer's contribution to the art. Suitably woven fabrics are dipped into solutions of the rare earth salts; these are dried and the organic matter burned out, leaving a structure of the metal oxides.

The pure thoria gives a relatively poor light. The addition of the ceria, up to a certain amount, increases the light. This added component is called the "excitant," and as the cause for this beneficial action of the excitant is not known, it is possible that further discoveries along this line will yet be made. There is hardly a prettier field for chemical speculation than is disclosed by the data on these light efficiencies. For some unknown reason, the change in composition by as little as one per cent. varies the luminosity over tenfold, and yet more than one per cent. of the excitant (ceria) reduces the light. Besides the temptation to speculation, such disclosures of nature encourage us to put greater trust in the value of new experiments, even when accumulated knowledge does not yield a blazed trail for the pioneer. By giving a discovery a name and attaching to it a mind-quieting theory, we are apt to close avenues of advance. Calling this small amount of ceria an "excitant" and guessing how it operates is directly harmful unless our guess suggests trial of other substances.

One of the explanations proposed to cover the action of the ceria ought to be mentioned, because it involves catalysis. This is a term without which no chemical lecture is complete. Some think that the special mantle mixture causes a more rapid and localized combustion, and therefore higher temperature, by condensation of gas in its material. Others think that this particular mixture permits of especially easy and rapid oxidation and reduction of its metal oxides themselves in the burning gas mixture. The power which catalyzers have of existing in two or more states of oxidation seems to apply also to the ceria of the Welsbach mantle. Whatever the truth

may be, it has been shown by Swinton[2] that when similar oxide mantles are heated to incandescence by cathode rays in vacuo, the presence of one per cent. ceria produces only a very small increase in the luminosity of thoria. It is interesting to note that in the gas flame *pure ceria* gives about the same light as *pure thoria,* while in the cathode rays of the Crookes tube, with conditions under which ceria gives almost no light, pure thoria gives an intense white light. These facts, which are still unexplained, illustrate how little is understood in this field.

I will merely refer to the fact that vapors of gasoline, kerosene, alcohol, etc., are also now used in conjunction with the Welsbach mantles. The field of acetylene I must also omit with a mere reference to the fact that the manufacture of calcium carbide was a chemical discovery, and the action of water upon it, producing the brilliantly-burning acetylene gas, was another.

Turning now to electrical methods of generating light, we find the chemist early at work. Sir Humphry Davy and others, at the dawn of the nineteenth century, showed the possibilities which since that time have been developed into our various types of incandescent and arc lamps. We naturally attach Mr. Edison's name to the development of the carbon incandescent lamp, because it was through his indefatigable efforts that a practicable lamp and illuminating system were both developed. It had long been known that platinum, heated by the current, gave a fair light, but it melted too easily. A truly enormous amount of work was done in attempts to raise the melting-point of the platinum, and the effect of occluded gases, of annealing, of crystalline condition, etc., were most carefully studied, but the results were unsatisfactory. He was therefore led to the element carbon as the next most promising conductor of high melting-point. Edison's persistent and finally successful attempts to get a dense, strong, practical filament of pure carbon for his lamps is one of the most encouraging lessons to the chemist of to-day. This history needs to be read in the light of the knowledge of carbon at that time and the severe requirements of a commercially useful carbon filament. It illustrates the value of continued effort when it is based on knowledge or sound reasoning. The search was not the groping in the dark that some of us have imagined, but was a resourceful search for the most satisfactory, among a multitude of possible materials. From our point of view, all subsequent changes in choice of material for incandescent lamp filaments have been dictated by the knowledge that high melting-point and low vapor tension were the first requirements. If you will consult the curve of the *melting-points* of all the *elements,* as plotted against their *atomic weights,* you will see at once that the desired property of high melting-point is a periodic function of the atomic weight. And it is this fact, which was independently disclosed as a general law by Meyer and Mendeljeff, in 1869, that has aided in the selection of all the new materials for this use. You will notice that the peaks of the curves are occupied by such elements as carbon, tantalum, tungsten, osmium, etc., which are all lamp materials.

A study of the laws of *radiation* also soon played a part in incandescent lamp work. The early rough and black filament of bamboo was first replaced by a polished black carbon filament, and later by one which had a bright, silver-gray coat of graphite. A black body at any temperature radiates the maximum possible energy in all wave-lengths. Heated to incandescence, it will *radiate more invisible and*

[2] *Proc. Roy. Soc.,* 65, 115.

useless infra-red rays than any other opaque material at the same temperature. A polished metal is therefore a more efficient light source than the same metal with a black, or even rough surface. This is derived from Kirchhoff's law of radiation and absorption, which was early established.

It may seem like penetrating too far into details to consider for a moment the changes in structure and surface which the carbon filament of our incandescent lamps has undergone, but the development of such an apparently closed problem is instructive because it has yielded to such simple methods of attack. The core, or body, of the carbon filament of to-day is made by some one of the processes based on dissolving and reprecipitating cellulose, which are used in artificial silk manufacture. The cellulose solution is squirted through a die into a liquid which hardens it into dense fibers. These cellulose fibers are then carbonized by being heated, out of contact with the air, at as high a temperature as possible with gas furnaces. All of this is also merely the application of chemistry which was first worked out in some of the German chemical laboratories. This plain carbon filament (the result of this simple process), which might have been satisfactory in the early days, would be nowadays useless in a lamp, as its practical life is only about 100 hours at 3 watts per candle. In a subsequent process of manufacture it is therefore covered with a steel gray coating of graphite, which greatly improves the light emitting power. This coat is produced by heating the filament in an atmosphere of benzene or similar hydrocarbons. The electric current which heats the filament is of such an intensity that the decomposition of the hydrocarbon produces a smooth, dense deposit of graphite. With this graphite-coat the filament now burns about 500 hours. But the simple graphite coat can itself be improved. It is improved by being subjected, for a few moments, in the electric furnace, to a temperature of about 3,500°, so that the life now becomes about 1,500 hours under the same operating conditions as before. The product of this treatment is known as the metallized filament, because its temperature coefficient of resistance is by this last step made similar to that of the metals.

A case is shown on the table which contains illustrations of the carbon incandescent lamp manufacture in the shape of cellulose solution, squirted cellulose fiber, carbonized fiber, etc.

Among the incandescent lamps which are before you I have one containing a platinum wire filament. You will see, as I turn on the current, that the intensity of its light is not very great, even when the current is sufficient to melt the wire. A much greater luminosity is produced by a plain carbon filament, and a still greater by the graphite-coated and metallized carbon, before they are destroyed. In the case of carbon, the useful life of the lamp depends much more on the vaporization of the material than on its melting-point, and these lamps, as shown, will operate for a short time at very much greater efficiencies or higher temperatures than is possible when a practical length of life is considered. Thus, besides the physical effect of surface quality, we have evidence of differences in the vapor pressure of different kinds of carbon. It looks as though carbonized organic matter yielded a carbon of much greater vapor pressure for given temperature than graphite, and that even graphite and metallized graphite are of quite distinctly different vapor pressures at high temperatures. It may be interesting to note here that if the carbon filament could withstand for 500 hours the maxi-

mum temperature which it withstands for a few moments, as shown in the experiments, then the cost of operating incandescent lamps could be reduced to nearly a fifth of the present cost.

It was discovered by Auer von Welsbach that the metal osmium could be made into a filament, though it could not be drawn as a wire. The osmium lamp was the first of the recent trio of metallic filament incandescent lamps. The tantalum lamp, in which another high melting-point metal replaces the superior but more expensive osmium, has been in use six or eight years. This surpasses the carbon in its action, and on running up to its melting-point it shows still brighter light than carbon. More recently the tungsten filament lamp has started to displace both lamps. At present this is the element which withstands the highest temperature without melting or vaporizing, and on being forced to its highest efficiency in a lamp you see that it reaches higher luminosity and that there is a similarity to carbon and tantalum in that an enormously greater efficiency may be produced for a very short time than can be utilized for a suitable length of life. The inherent changes at these temperatures, distillation or whatever they are, quickly destroy the lamp. The lamp will burn an appreciable time at an efficiency fifteen times as great as that of the common operating carbon incandescent lamp (at 3 watts per candle). In other words, light may be produced for a short time at an energy-cost one fifteenth of common practise, so that there is still a great field for further investigation directed towards merely making stationary those changing conditions which exist in the burning lamp.

While it is generally true that the light given by a heated body increases very rapidly with rise of temperature above 600°, the regularity of the phenomenon is commonly over-estimated. A certain simple law covering the relation between the temperature and the light emitted, has been found to apply to what we have called a black body. This so-called Stefan-Boltzmann law states that "the total intensity of emission of a black body is proportional to the fourth power of the absolute temperature." There are, however, very few real black bodies in the sense of the law. The total emission from a hole in the wall of a heated sphere has been shown experimentally to follow the law rigidly, but most actual forms and sources of illumination do not. Most practical sources of artificial light are more efficient light producers than the simple law requires. This may be said to be due to the fact that these substances have characteristic powers of emitting relatively more useful energy as light than energy of longer wave-length (or heat rays). Most substances show a power of selective emission and we might say that an untried substance, heated to a temperature where it should be luminous, could exhibit almost any conceivable light effect. It is still less possible to predetermine the proportionality between luminous and non-luminous emission. A simple illustration will serve to make this clear: if a piece of glass be heated to 600°, it does not emit light. If some powder such as zirconia or thoria be sprinkled upon it, light is emitted and the proportion of light at the same temperature will depend upon the composition of the powder. Coblentz has shown, both for the Auer mantle and for the Nernst glower, that the emission spectra are really series emission bands in that portion of the energy curve which represents the larger part of the emitted energy. This is in the invisible infra-red part, and so the laws which govern the emission at a given temperature depend upon the chemical composition of the radiant source. Sili-

cates, oxides, etc., show characteristic emission bands.

One of the most attractive fields of artificial light production has long been that of luminous gases or vapors. It has seemed as though this ought to be a most satisfactory method. The so-called Geissler tubes in which light is produced by the electrical discharge through gases at low pressure are familiar to all. The distribution of the energy emitted from gases is still further removed than that of solids from the laws of a black body, and a large proportion of the total electrical energy supplied to a rarefied gas may be emitted as lines and bands which are within the range of the visible spectrum. These lines, under definite conditions of pressure, etc., are characteristic of the different elements and compounds. The best known attempts to utilize this principle are the Moore system of lighting, in which long tubes of luminous gas are employed, and the mercury lamps, which, while more flexible on account of size, are still objectionable because of the color of the light. A simple form of mercury arc is shown.

It is rather interesting that the efficiencies of all of these various sources of electric light are not nearly so widely different as one would expect from a consideration of the widely divergent methods of light production employed.

From the light of a vapor or gas to that of an open arc is not a wide step, but the conditions in the arc are apparently quite complex and there is a great deal of room for interesting speculation in the phenomena of an arc. Briefly, there are two kinds of arcs to be considered in lighting. One has been in use for a century, the other for a few years only. The first is the successor to Sir Humphry Davy's historical arc between charcoal points. In this kind of arc the current path itself is hardly luminous and the light of the lamp is that given by the heated electrodes. In case of direct current it is the anode, or positive electrode, which gets the hotter and gives far the greater part of the light. In the carbon arc shown, it will readily be seen that the light is emitted by the heated solid carbon of one electrode. This gives a steady source of light, but is not so efficient as an arc in which material in the arc stream itself is the source of light. The arc may be made to play upon rare earth oxides, and these, being heated to incandescence, increase the luminosity, but this has not proved useful. The more common way is to introduce into the carbon electrode certain salts which volatilize into the arc and give a luminous effect. Here cerium fluoride, calcium fluoride, etc., are used, and the color of the arc, just as in the case of gas mantles, may be varied by varying the composition of the electrodes. This is seen in the arc from the carbon electrodes containing such salts.

I have arranged several different kinds of arcs, and before each is a magnifying lens, to throw the image of the arc upon a screen. This permits our seeing the phenomena of the arcs and observing the characteristics of each. The very essential differences between the plain carbon arc and the luminous or flaming arc is readily noticed. In the latter case the greater part of the light is due to the incandescent metallic vapors in the space between the electrodes. Substitution of one chemical for another in such flaming arc electrodes has covered quite a wide range of chemical investigation. Salts are chosen which give the greatest luminosity without causing the formation of too much ash or slag. Some compounds of calcium, for example, are practicable, while others are not, though all of these would, under suitable conditions, yield the calcium spectrum.

If such salts as calcium fluoride were conductors at ordinary temperature, useful electrodes for flame arcs would probably be made from them. Such conducting materials as iron oxide, carbides, etc., have been used for flame arc electrodes, and a great many of the so-called magnetite arcs are now in use. The electrodes in this case are largely magnetic oxide of iron, with such other ingredients as titanium and chromium oxides, to increase the intensity of light, to raise the melting-point of the mixture, etc.

As will be seen from observing this arc, the light is very white and intense and is generated by the heated vapors of the arc proper. A great many modifications of this arc principle are possible. Titanium carbide and similar substances give characteristic arcs, and some of them are very intense and efficient. For purposes of comparison, I have added to this illustrating experiment an arc of titanium carbide and one of copper.

THE NERNST LAMP

A distinct species of electric incandescent lamp is that invented about ten years ago by the well-known physical chemist, Professor Nernst. This employs for filaments a class of bodies which are not electrical conductors at all at ordinary temperatures, and which, at their burning temperatures, do not conduct the current as metals and carbon, but as a solution does. This kind of conductivity, the electrolytic, involves electrochemical decomposition at the electrodes, and in the case of the Nernst filaments these otherwise destructive reactions are rendered harmless by the continual oxidizing action of the air. For this reason this type of lamp will not burn in vacuo. For its most perfect utility the principle of the Nernst lamp seems to require a mixture of oxides, because a single one is not so good a conductor nor so luminous. It uses oxides because these are the most stable compounds known, and it uses the rare earth oxides because they have higher melting-point than other oxides. As the efficiency very rapidly rises with temperature, there is a great advantage in using the most infusible base possible. For that reason, zirconia, thoria, etc., are usually employed.

In this lamp a rod or filament of an oxide mixture, much like those used in Welsbach mantles, is heated by the current externally applied until it reaches a temperature at which it becomes a good conductor itself. Here again the peculiar laws of light radiation are illustrated, the light emitted at a given temperature being determined by the nature of the substance. Just as the pure thoria gives a poor light compared to the mixture with one per cent. ceria, so a pure zirconia rod, heated by the current, gives much less light than a rod containing a little thoria, ceria or similar oxide. Work done by Coblentz on the energy-emission of such rods shows the emission spectra, at least in the infra-red, to vary with the nature of the substance. In general, the spectra are not continuous like the spectra of metals and black bodies, but seem to occupy an intermediate position between these and luminous gases, which we know have usually distinct line spectra.

This recalls the subject of selective emission. Coblentz has shown selective emission in the long wave-lengths for a Nernst glower. This is shown in comparison with the emission of a black body, in curve No. 1. The two sources, when compared at the temperatures where they exhibit the same wave-length for maximum emission, differ very considerably in emission in the infra-red, the black body giving more energy at the blue end and less at the red end of the spectrum.

This is still more noticeable in the curves

for such substances as porcelain, magnesia and glass, as shown by Coblentz's curves (Fig. 2).

The curves of wave-length and radiant energy which are shown are, with slight

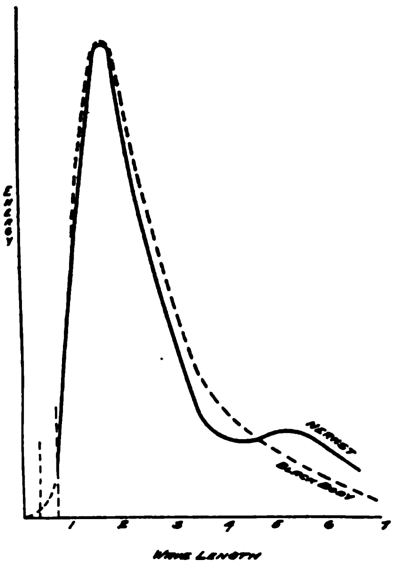

FIG. 1

modifications, taken from work of Lummer and Pringsheim and of Dr. Coblentz. The

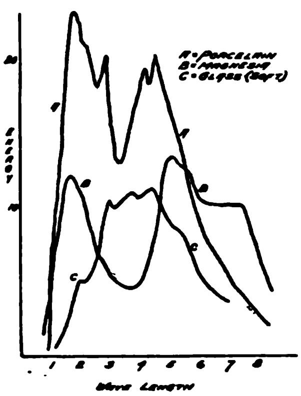

FIG. 2

curve for the ideal, or black body radiator, gives a picture of the total energy and its distribution over the different wave-lengths. It is the peculiarity of the black body to radiate more energy of any given wave-length than does any other body at the same temperature. Therefore, in case of all substances acting as thermal radiators, the black body will always give the greatest brilliancy. Since this body at the same time radiates a maximum in *all* wave-lengths, it will be surpassed in light *effi-*

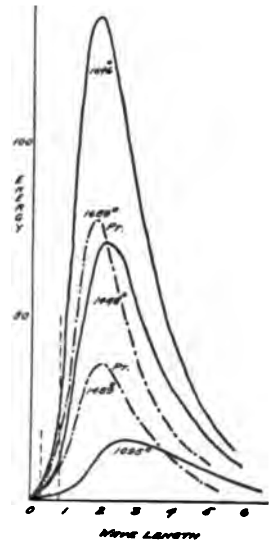

FIG. 3

ciency by any substance which is a relatively poor radiator in the invisible or non-luminous part of the spectrum.

In the energy curves shown it is to be noticed that the visible part of the energy is practically only that between 0.4 and 0.8 thousandths of a millimeter. Consider the black lines in Fig. 3 for a moment. These show the emission of a black body at centigrade temperatures noted on the curves. Evidently the energy emitted rises very rapidly with the temperature; *i. e.*, as the fourth power of the absolute temperature. It will be noted also that the point of maximum energy or wave-length corresponding to maximum energy shifts gradually to-

wards the left, or towards the visible wave-lengths.

It is this rapid shifting of the position of maximum energy which makes the search for substances which can withstand even only slightly higher temperatures of such great interest.

The curves for the black body and for platinum (dotted lines) are not greatly different in general appearance, but the total amount of energy emitted at a given temperature from the black body is shown to be more than for the platinum, and it can be seen that at about the same temperature the platinum is the more economical light source. Professor Lummer has said that at red heat, bright platinum does not radiate *one tenth* the total energy which the ideal black body radiates at the same temperature, and at the highest temperature still less than one half. The deviation of platinum from the black body law is a step in the direction of getting improved light-efficiency without corresponding increase of temperature. This method is practically without limit in its extension, for there seems to be no limit to the forms of energy curves which different substances may possess. The curves are apparently determined not only by physical state, but also by chemical composition of the emitting substance.

You see before you a vacuum incandescent lamp which contains a ribbon of platinum in the shape of a loop. While the section of the platinum is the same throughout, one half of the loop is blackened by depositing a little platinum black upon it. This greatly affects the light efficiency as shown. The blackened portion, being more nearly a black body, radiates at each temperature relatively more energy of long wave-length (*i. e.*, heat) than the bright portion. So for about equal total energy radiated the ribbon radiates less as light from the blackened surface.

In the production of artificial light, the tendency will always be in the direction of increasing the practical efficiency, *i. e.*, reducing the cost of light. We have seen that there is still much room for this. In the case of the kerosene oil lamp we know that much less than one per cent. of the energy of combustion of the oil is radiated as light from the flame. In the case of the most efficient source—the electric incandescent lamp at *highest* efficiency—we are still far from ideal efficiency. A still higher temperature would yield a yet higher efficiency. We do not know exactly how much light might possibly be yielded for a given consumption of energy, but one experimenter concludes that it is about ten candles per watt. If this is true, even the most efficient light you have seen this evening is less than half as efficient as it might be. Fortunately, it is not now clear just how the chemist is to realize all the advances which he will make in more efficient lights.

No consideration of this part of the subject is complete without a brief reference to the efficiency of the fire-fly. The source of his illumination is evidently chemical. This much is known about the process:

The light-giving reaction is made to cease by the removal of the air, and to increase in intensity by presence of pure oxygen. It is extinguished in irrespirable gases, but persists in air some time after the death of the insect. Its production is accompanied by the formation of carbon dioxide. These all indicate a chemical combustion process. Professor Langley has shown that such a flame as the candle produces several hundred times as much useless heat as the total radiation of the fire-fly for equal luminosity. In other words, the fire-fly is the most efficient light source known. This is illustrated by the energy distribution curves from several

light sources taken from Professor Langley's work (Fig. 4). The difficulties attendant upon the accurate determination of the curve for the fire-fly are so great that we ought not to expect very great accuracy in this case. These curves, which in each case refer to the energy after pass-

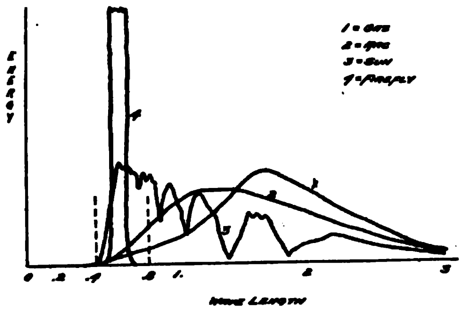

FIG. 4

ing through glass, which cuts off energy of long wave-lengths, represent the same quantities of radiant energy. While the sun is much more efficient than the gas flame or carbon arc, it still presents far the largest part of its energy in the invisible long wave-lengths (above 0.8), while the fire-fly seems to have its radiant energy confined to a narrow part of the visible spectrum.

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RACIAL DIFFERENCES IN MENTAL TRAITS[1]

ONE of the most agreeable and satisfying experiences afforded by intellectual pursuits comes from the discovery of a clean-cut distinction between things which are superficially much alike. The esthetic value of such distinctions may even outweigh their intellectual value and lead to sharp lines and antitheses where the only difference that exists is one of degree. A favorite opportunity for this form of intellectual exercise and indulgence is afforded by the observation of groups of men. The *type* of man composing each group—that is what we should like to find; and we hear much of the "typical" scientist, the typical business man, the typical Englishman or Frenchman, the typical southerner, the typical Bostonian. The type of any group stands as a sort of ideal within the group, and, more or less caricatured, as the butt of the wit of other groups. There is one peculiar fact about these types: you may have to search long for an individual who can be taken as a fair example. And when you have at last found the typical individual, you may be led to ask by what right he stands as the type of the group, if he is a rarity amidst it.

If we would scientifically determine the facts regarding a group of men, we should, no doubt, proceed to examine all the individuals in the group, or at least a fair and honest representation of them. The first fact that meets us when we proceed in this way is that the individuals differ from each other, so that no one can really be selected as representing the whole number. We do find, indeed, when we measure the stature or any other bodily fact, or when we test any native mental capacity, that the members of a natural group are disposed about an average, many of them lying near the average, and few lying far above or far below it; and we thus have the average as a scientific fact regarding the group. But the average does not generally coincide with the type, as previously conceived, nor do the averages of different groups differ so much as the so-called types differ. Moreover, the average is itself very inadequate, since it does not indicate the amount of variation that exists within the group—

[1] Address of the vice-president and chairman of Section H—Anthropology and Psychology—of the American Association for the Advancement of Science, Boston, 1909.

and this is one of the most important facts to be borne in mind in understanding any collection of individuals. It is specially important in comparing different groups of men, since the range of variation within either group is usually much greater than the difference between the averages of the groups. The groups overlap to such an extent that the majority of the individuals composing either group might perfectly well belong to the other.

No doubt statements like this will be readily accepted as far as concerns the different nations belonging to the same race. One could not seriously doubt that the nations of Europe, though they might differ slightly on the average, would so much overlap one another that, except for language and superficial mannerisms, the great majority of the members of one nation might be exchanged with a majority from another nation without altering the characteristics of either. But when we extend our view to all the peoples of the earth, the case would at first appear quite changed. Certainly whites and negroes do not overlap, to any extent, in color of skin, nor negroes and Chinamen in kinkiness of hair, nor Indians and Pygmies in stature. Such specialization of traits is, however, the exception. Whites and negroes, though differing markedly in complexion and hair, overlap very extensively in almost every other trait, as, for example, in stature. Even in brain weight, which would seem a trait of great importance in relation to intelligence and civilization, the overlapping is much more impressive than the difference; since while the brain of negroes averages perhaps two ounces lighter than the brain of Europeans, the range of variation within either race amounts to 25 ounces.

Our inveterate love for types and sharp distinctions is apt to stay with us even after we have become scientific, and vitiate our use of statistics to such an extent that the average becomes a stumbling-block rather than an aid to knowledge. We desire, for example, to compare the brain weights of whites and of negroes. We weigh the brains of a sufficient number of each race —or let us at least assume the number to be sufficient. When our measurements are all obtained and spread before us, they convey to the unaided eye no clear idea of a racial difference, so much do they overlap. If they should become jumbled together, we should never be able to separate the negroes from the whites by aid of brain weight. But now we cast up the average of each group, and find them to differ; and though the difference is small, we straightway seize on it as the important result, and announce that the negro has a smaller brain than the white. We go a step further, and class the white as a large-brained race, the negro as a small-brained. Such transforming of differences of degree into differences of kind, and making antitheses between overlapping groups, partakes not a little of the ludicrous.

We seem to be confronted by a dilemma; for the group as a whole is too unwieldy to grasp, while the average, though convenient, is treacherous. What we should like is some picture or measure of the *distribution* of a given trait throughout the members of a group; and, fortunately, such measures and pictures can be had. Convenient and compact measures of variability are afforded by the science of statistics, and are of no less importance than the average. But still better, because closer to the actual facts, are graphic or tabular pictures of the distribution of the trait, showing the frequency with which it occurs in each degree. The distribution of a trait is for some purposes more important than the average. Let us suppose, for instance,

that two groups were the same in their average mental ability, but that one group showed little variation, all of its members being much alike and of nearly the average intelligence, while the other group showed great variability, ranging between the extremes of idiocy and genius. It is evident that the two groups, though equal on the average, would be very unequal in dealing with a situation which demanded great mental ability. One master mind could supply ideas for the guidance of the group, and his value would far outweigh the load of simpletons which the group must carry.

If groups of men differ in average intelligence, this difference would have an influence on their effectiveness in mental work, and so, no doubt, on their advance in civilization. If groups differ in variability, this would probably have a still greater influence. There is one respect in which groups certainly do differ. They differ in size, and size is an important consideration, even from a purely biological point of view. The more numerous the individuals born into a group, the greater the absolute number of gifted individuals to be expected; and in some respects it is the absolute rather than the relative number of able men that counts. Besides this, the larger the group, the greater the chance of its producing a truly effective genius, just as, in the experiments of Burbank and other breeders, a vast number of plants are grown, in order to increase the chance of sports occurring.

One further consideration of this partly biological, partly statistical, nature should be brought forward before passing from preliminary remarks to the consideration of actual data. When the individuals composing a group are measured or tested in several traits, it is found that those who rank high in one trait do not always rank high in others. On the whole, there is more correspondence than opposition; an individual who ranks well in one trait is rather apt to rank well in others. The correlation, as we say, is positive, but it is far from perfect. The individuals most gifted with ability in war are not altogether the same individuals who are ablest in government, or in art or literature, or in mechanical invention. This fact is not only of importance in reaching a just conception of a group, but it should be considered in comparing different groups. The circumstances surrounding a group call for certain special abilities, and bring to the fore the individuals possessing these abilities, leaving in comparative obscurity those gifted in other directions. Judging the group largely by its prominent individuals, we get the impression that the group is gifted in certain lines, and deficient in others. A nation whose circumstances call for industrial expansion and the exploitation of natural resources gives prominence to those of its members who are successful in these pursuits, and leaves in obscurity many who have native capacity for military leadership. Should war come to such a community, time and bitter experience are often necessary before the leadership can be transferred from the previously eminent men to those obscure and often despised individuals who are capable of doing best service in the new direction. This lack of perfect correlation between various abilities makes it difficult to judge of the capacity of a group of men by casual observation; and we must accordingly discount largely the appearance of specialization of mental traits in different peoples.

All in all, the discovery of true inherent differences between races and peoples is an intricate task, and if we now turn to the psychologist to conduct an examination of different groups, and to inform us regarding their mental differences, we must not

allow him to present a hasty conclusion. His tests must be varied and thorough before we can accept his results as a serious contribution to this difficult subject. The psychologist may as well admit at once that he has little to offer; for, though the "psychology of peoples" has become a familiar phrase, and though books have been written on the subject, actual experimental work has so far been very limited in quantity.

One thing the psychologist can assert with no fear of error. Starting from the various mental processes which are recognized in his text-books, he can assert that each of these processes is within the capabilities of every group of mankind. All have the same senses, the same instincts and emotions. All can remember the past, and imagine objects not present to sense. All discriminate, compare, reason and invent. In all, one impulse can inhibit another, and a distant end can be pursued to the neglect of present incitations. Statements to the contrary, denying to the savage powers of reasoning, or abstraction, or inhibition, or foresight, can be dismissed at once. If the savage differs in these respects from the civilized man, the difference is one of degree, and consistent with considerable overlapping of savage and civilized individuals. The difference of degree calls for quantitative tests. But besides the traditional classification of mental powers, there is another of perhaps greater importance in studying differences between men. One individual differs from another not so much in power of memory, or of reasoning, or of attention, or of will, as in the sort of material to which he successfully applies these processes. One gives his attention readily to mathematics; he remembers mathematics easily; he reasons well on mathematical subjects; his will is strong in excluding distracting impulses when he is in pursuit of a mathematical goal. He may show none of these powers, in a high degree, in relation to music, or business, or social life; whereas another, totally inefficient in mathematics, may show equal powers of mind in another subject. The capacity to handle a given sort of subject matter is in part determined by native endowment, but is very responsive to training, and therefore is hard to test, because only individuals with equal training in any subject can be fairly tested and compared as to their native capacity to handle that subject. Thus it becomes hard to contrive a test for musical or mathematical or mechanical endowment which could fairly be applied to races having diverse trainings in these lines. This difficulty, moreover, infects our tests for such general powers as memory or reasoning, for a test has to deal with some sort of material, and success in passing the test depends on the familiarity of the material as well as on the power of mind which we design to test. We may suppose, indeed, that all of our tests, founded as they are on material which is familiar to us, will be more or less unfair to peoples of very different cultures and modes of life. The results of our tests need to be discounted somewhat—exactly how much we can not say—in favor of the primitive peoples tested.

We are now, it would seem, sufficiently entrenched in precautions and criticisms to admit the psychologist to our councils, and hear the results of his tests.

First, as to the senses. The point of special interest here is as to whether the statements of many travelers, ascribing to the "savage" extraordinary powers of vision, hearing and smell, can be substantiated by exact tests. The common opinion, based on such reports, is, or has been, that savages are gifted with sensory powers quite beyond anything of which the European is capable; though Spencer explains

that this is a cause of inferiority rather than the reverse, because the savage is thus led to rely wholly on his keen senses, and to devote his whole attention to sense impressions, to the neglect and atrophy of his intellectual powers. Ranke, however, on testing natives of Brazil, a race notable for its feats of vision, found that their ability to discern the position of a letter or similar character at a distance, though good, was not remarkable, but fell within the range of European powers. The steppe-dwelling Kalmuks, also renowned for distant vision, being able to detect the dust of a herd of cattle at a greater distance with the naked eye than a European could with a telescope, have also been examined; and their acuity was indeed found to be very high, averaging considerably above that of Europeans; yet only one or two out of the forty individuals tested exceeded the European record, while the great majority fell within the range of good European eyes. Much the same result has been obtained from Arabs, Egyptians and quite a variety of peoples. Among the most reliable results are those of Rivers on a wholly unselected Papuan population. He found no very exceptional individual among 115 tested, yet the average was somewhat better than that of Europeans. I had myself, through the kindness of Dr. McGee, the opportunity of testing individuals from quite a variety of races at the St. Louis Fair in 1904, and my results agree closely with those already cited, though I did not find any cases of very exceptional powers among about 300 individuals. There were a number who exceeded the best of the 200 whites whom I also tested under the same conditions, but none who exceeded or equaled the record of a few individuals who have been found in the German army. Indians and Filipinos ranked highest, averaging about 10 per cent. better than whites, when all individuals of really defective vision were excluded. The amount of overlapping is indicated by stating that 65–75 per cent. of Indians and Filipinos exceeded the average for whites. It did not seem possible, however, to assert anything like a correspondence between eyesight and the degree of primitiveness or backwardness of a people; since, for instance, the Negritos of the Philippine Islands, though much more primitive than the Malayan Filipinos in their mode of life, and, indeed, the most primitive group so far tested, were inferior to the Filipinos, and, in fact, as far as could be judged from the small number examined, no whit superior to whites. Nor does it seem possible, from results hitherto reported, to believe in a close correspondence between keen sight and dark skin, though it is true that pigment is important in several ways to the eye, and that therefore, as Rivers has suggested, the amount of pigmentation might be a factor in vision. But it does not seem to be specially the darkest races that show the keenest vision. We may perhaps conclude that eyesight is a function which varies somewhat in efficiency with difference of race, though with much overlapping. No doubt, however, the results as they stand need some qualification. On the one hand, inclusion of individuals with myopia and similar defects would lower the average of Europeans considerably more than that of most other races; so that the actual condition of eyesight differs more than the results show. On the other hand, it would not be fair to include near-sighted individuals, if what we wish to discover is native differences between peoples; for the different prevalence of myopia is certainly due to the differing uses to which the eye is put. And this matter of use may have considerable influence on the individuals not classed as near-sighted, and so admitted to the comparison.

Rivers has made an observation in connection with the test for eyesight, which I am able to confirm, and which is perhaps of much importance. He found that when the letter or character used in his test, the position of which had to be recognized at the greatest possible distance, was removed from him beyond the distance at which he felt that he could judge it, he could still guess it right nearly every time, though without confidence. By such guessing, one's record in this test can be bettered considerably; and careful study enables one to see the slight and blurred indications of position which form the basis of the guessing. Now it may well be that the occupations of civilized life breed a habit of dependence on clear vision, whereas the life of those who must frequently recognize objects at a great distance breeds reliance on slight indications, and so creates a favorable attitude for the test of eyesight. When this possibility is taken in connection with the deterioration of many European eyes from abuse, and in connection with the observed overlapping of all groups tested, the conclusion is not improbable that, after all, the races are essentially equal in keenness of vision. Even if small differences do exist, it is fairly certain that the wonderful feats of distant vision ascribed to savages are due to practise in interpreting slight indications of familiar objects. Both Rivers and Ranke, on testing some of the very individuals whose feats of keen sight seemed almost miraculous, found that, as tested, they had excellent but not extraordinary vision. A little acquaintance with sailors on shipboard is enough to dispel the illusion that such feats are beyond the powers of the white man.

The hearing of savages enjoys a reputation, among travelers, similar to that of their sight; but there can be little doubt that the cause is the same. In fact, the tests which have so far been made tend to show that the hearing of whites is superior. Such was the result of Myers on the Papuans, and of Bruner in his extensive series of measurements made at the St. Louis Fair. Only 15 per cent. of 137 Filipinos tested did as well as the average of whites; other groups made a somewhat better showing, but all seemed inferior on the average to whites. In spite of the experimental results, there is perhaps reason to doubt that the hearing of whites is essentially and natively much superior to that of other races. Civilized life protects the ear from some forms of injury to which it is exposed in more primitive conditions; and, then, the question of cleanliness must be considered in regard to the meatus. Besides, the ear is known to be highly susceptible of training in the perception of particular sorts of sound—as overtones and difference tones—and it is likely enough that the watch ticks and similar clicks used in the tests are not equally within the repertory of all peoples.

Much the same can be said regarding keenness of smell. On account of the high olfactory powers of dogs and some other lower animals, it has often seemed natural and proper that this sense should be highly developed among savages; and feats of primitive folk have been reported quite analogous to those already referred to under sight and hearing. No doubt here again, special interests and training are responsible, since what few tests have been made tend to show no higher acuity of smell among negroes and Papuans than among Europeans.

The sense of touch has been little examined. McDougall found among the Papuans a number with extremely fine powers of discrimination by the skin. The difference between two points and one could be told by these individuals even when the

two points were brought very close together; on the average, the Papuans tested excelled Europeans considerably in this test. On the other hand, Indians and Filipinos, and a few Africans and Ainu, tested in the same manner, seem not to differ perceptibly from whites.

The pain sense is a matter of some interest, because of the fortitude or stolidity displayed by some races towards physical suffering. It may be, and has been conjectured, that the sense for pain is blunt in these races, as it is known to be in some individuals who have allowed themselves to be burned without flinching, and performed other feats of fortitude. The pain sense is tested by applying gradually increasing pressure to some portion of the skin, and requiring the person tested to indicate when he first begins to feel pain. Now, as a matter of fact, the results of McDougall on the Papuans, and those of Dr. Bruner and myself on Indians, Filipinos, Africans and Ainu, are in close agreement on this point. Greater pressure on the skin is needed to produce pain in each of these races than in whites. This is the average result, but in this test the distribution of the cases is specially important. Though most whites feel pain at or about a certain small pressure, there is quite a respectable minority who give no sign till much higher pressures are reached, their results corresponding very closely to those of the majority of Indians. And similarly, a minority of Indians feel pain at much lower pressures than the bulk of their fellows, falling into the ranks of the white man. In each group, the distribution is bimodal, or aggregated about two points instead of one; but whites are principally aggregated about the lower center, and Indians and other races about the higher center. Introspection comes to our aid in explaining this anomaly, for it shows that there is some difficulty in telling just when the pressure becomes painful. If one is satisfied with slight discomfort, a moderate pressure will be enough; but if a sharp twinge is demanded, the pressure must be considerably increased. Most whites, under the conditions of the test, are satisfied with slight discomfort, while my impression in watching the Indians was that they were waiting to be really hurt. The racial difference would accordingly be one in the conception of pain, or in understanding the test, rather than in the pain sense.

On the whole, the keenness of the senses seems to be about on a par in the various races of mankind. Differences exist among the members of any race, and it is not improbable that differences exist between the averages of certain groups, especially when these are small, isolated and much inbred. Rivers has in fact found such small groups differing considerably from whites in the color sense. One such group showed no cases of our common color blindness or red-green blindness, while another group showed an unusually large percentage of color-blind individuals. In the larger groups, the percentage of the color-blind is, very likely, about constant, though the existing records tend to show a somewhat lower proportion among Mongolians than among whites. Very large numbers of individuals need, however, to be tested in order to determine such a proportion closely; even among Europeans, the proportion can not yet be regarded as finally established. One thing is definitely shown by the tests that have been made for color blindness in various races: no race, however primitive, has been discovered in which red-green blindness was the universal or general condition; and this is a fact of some interest in connection with the physiology of color vision, for it seems probable that red-green blindness, since it

is not by any means a diseased condition, represents a reversion to a more primitive state of the color sense. If this is so, no race of men remains in the primitive stages of the evolution of the color sense; the development of a color sense substantially to the condition in which we have it, was probably a pre-human achievement.

In the actual history of the discussion of the color sense in various races, quite a different view of the evolution has been prominent. It was Gladstone who first, as an enthusiastic student of Homer, was struck by the poverty of color names in ancient literature, and who suggested that the Greeks of the Homeric age had a very imperfectly developed eye for color. He was especially impressed by the application of the same color name to blue and to gray and dark objects. Geiger, adhering to the same sort of philological evidence, broadened its scope by pointing out the absence of a name for blue in other ancient literatures. It is indeed curious that the sky, which is mentioned hundreds of times in the Vedas and the Old Testament, is never referred to as blue. The oldest literatures show a similar absence of names for green. Geiger found that names for black, white and red were the oldest, and that names for yellow, green and blue have appeared in that order. He concluded that the history of language afforded an insight into the evolution of the color sense, and that, accordingly, the first color to be sensed was red, the others following in the same order in which they occur in the spectrum. Magnus found that many languages at the present day were in the same condition as that shown in the ancient Greek, Hebrew and Sanscrit. Very many, perhaps the majority, have no specific name for blue, and a large proportion have none also for green. A smaller number are without a name for yellow, while nearly all have a name for red. It seemed that the backward races of to-day had just reached the stage, in the matter of color sensation, which was attained by other races some thousands of years ago. The underlying assumptions of this argument are interesting—the notion that the list of sensations experienced by a people must find expression in its vocabulary; and the conception of certain peoples now living as really primitive. Fortunately, Magnus submitted this theory to the test of facts, by supplying travelers and traders with sets of colors, by which various peoples were tested, first, as to their ability to name the colors in their own languages, and second, as to their power to recognize and distinguish the colors. The results of this inquiry were that names were often lacking for blue and green, but that every people was able to perceive the whole gamut of colors known to the European. This was a severe blow alike to the philological line of argument and to the ready assumption that early stages of evolution were to be found represented in the backward peoples of to-day. Accepting the facts as they stood, Magnus still felt that there must be some physiological or sensory reason for the curious lack of certain color names in many languages; and he therefore suggested that blue and green might be less vividly presented by the senses of many tribes, and that, being duller to their eyes than to Europeans, these colors did not win their way into the language. The theory was, however, practically defunct for many years till Rivers recently took it up, as the result of tests on several dark-skinned peoples. His test called for the detection of very faint tints of the various colors, and the result was that, as compared with twoscore educated English whom he also tested, these peoples were somewhat deficient in the detection of faint tints of blue—and also of yellow—but

not of red. One group, indeed, was superior to the English in red. The results made it seem probable to Rivers that blue was indeed a somewhat less vivid color to dark-skinned races than to Europeans, and he suggested that pigmentation, rather than primitiveness, might be the important factor in producing this difference. A blue-absorbing pigment is always present in the retina, and the amount of it might very well be greater in generally pigmented races. The suggestion is worth putting to a further test; but, meanwhile, the difference obtained by Rivers in sensitiveness to blue needs to be received with some caution, since the Europeans on whose color sense he relies for comparison were rather few in number, educated and remarkably variable among themselves. We were able, at St. Louis, to try on representatives of a number of races a difficult color matching test, so different indeed from that of Rivers that our results can not be used as a direct check on his; with the result that all other races were inferior to whites in their general success in color matching, but that no special deficiency appeared in the blues. We also could find no correlation between ill success in this test and the degree of pigmentation. On the whole, the color sense is probably very much the same all over the world.

That linguistic evidence is a very treacherous guide to the sensory powers of a people is well seen in the case of smell. Certainly many odors are vivid enough, yet we have no specific odor names. Only a psychologist would require a complete vocabulary of sensations; practical needs lead the development of language in quite other directions.

When we turn from the senses to other functions, the information which the psychologist has to offer becomes even more scanty.

Some interest attaches to tests of the speed of simple mental and motor performances, since, though the mental process is very simple, some indication may be afforded of the speed of brain action. The reaction time test has been measured on representatives of a few races, with the general result that the time consumed is about the same in widely different groups. The familiar "tapping test," which measures the rate at which the brain can at will discharge a series of impulses to the same muscle, was tried at St. Louis on a wide variety of folk, without disclosing marked differences between groups. The differences were somewhat greater when the movement, besides being rapid, had to be accurate in aim. The Eskimos excelled all others in this latter test, while the poorest record was made by the Patagonians and the Cocopa Indians—which groups were, however, represented by only a few individuals. The Filipinos, who were very fully represented, seemed undeniably superior to whites in this test, though, of course, with plenty of overlapping.

The degree of right-handedness has been asserted to vary in different races, and the favoring of one hand has been interpreted as conducive to specialization and so to civilization. We were, however, unable to detect any marked difference in the degree of right-handedness in different races, as tested by the comparative strength, quickness or accuracy of the two hands. The Negritos, the lowest race examined, had the same degree of right-handedness as Filipinos, or Indians, or whites.

We are probably justified in inferring from the results cited that the sensory and motor processes, and the elementary brain activities, though differing in degree from one individual to another, are about the same from one race to another.

Equitable tests of the distinctly intel-

lectual processes are hard to devise, since much depends on the familiarity of the material used. Few tests of this nature have as yet been attempted on different races.

There are a number of illusions and constant errors of judgment which are well-known in the psychological laboratory, and which seem to depend, not on peculiarities of the sense organs, but on quirks and twists in the process of judgment. A few of these have been made the matter of comparative tests, with the result that peoples of widely different cultures are subject to the same errors, and in about the same degree. There is an illusion which occurs when an object, which looks heavier than it is, is lifted by the hand; it then feels, not only lighter than it looks, but even lighter than it really is. The contrast between the look and the feel of the thing plays havoc with the judgment. Women are, on the average, more subject to this illusion than men. The amount of this illusion has been measured in several peoples, and found to be, with one or two exceptions, about the same in all. Certain visual illusions, in which the apparent length or direction of a line is greatly altered by the neighborhood of other lines, have similarly been found present in all races tested, and to about the same degree. As far as they go, these results tend to show that simple sorts of judgment, being subject to the same disturbances, proceed in the same manner among various peoples; so that the similarity of the races in mental processes extends at least one step beyond sensation.

The mere fact that members of the inferior races are suitable subjects for psychological tests and experiments is of some value in appraising their mentality. Rivers and his collaborators approached the natives of Torres Straits with some misgivings, fearing that they would not possess the necessary powers of sustained concentration. Elaborate introspections, indeed, they did not secure from these people, but, in any experiment that called for straightforward observation, they found them admirable subjects for the psychologist. Locating the blind spot, and other observations with indirect vision, which are usually accounted a strain on the attention, were successfully performed. If tests are put in such form as to appeal to the interests of the primitive man, he can be relied on for sustained attention. Statements sometimes met with to the effect that such and such a tribe is deficient in powers of attention, because, when the visitor began to quiz them on matters of linguistics, etc., they complained of headache and ran away, sound a bit naïve. Much the same observations could be reported by college professors, regarding the natives gathered in their class rooms.

A good test for intelligence would be much appreciated by the comparative psychologist, since, in spite of equal standing in such rudimentary matters as the senses and bodily movement, attention and the simpler sorts of judgment, it might still be that great differences in mental efficiency existed between different groups of men. Probably no single test could do justice to so complex a trait as intelligence. Two important features of intelligent action are quickness in seizing the key to a novel situation, and firmness in limiting activity to the right direction, and suppressing acts which are obviously useless for the purpose in hand. A simple test which calls for these qualities is the so-called "form test." There are a number of blocks of different shapes, and a board with holes to match the blocks. The blocks and board are placed before a person, and he is told to put the blocks in the holes in the shortest possible time. The key to the situation is here the

matching of blocks and holes by their shape; and the part of intelligence is to hold firmly to this obvious necessity, wasting no time in trying to force a round block into a square hole. The demand on intelligence certainly seems slight enough; and the test would probably not differentiate between a Newton and you or me; but it does suffice to catch the feebleminded, the young child, or the chimpanzee, as any of these is likely to fail altogether, or at least to waste much time in random moves and vain efforts. This test was tried on representatives of several races, and considerable differences appeared. As between whites, Indians, Eskimos, Ainus, Filipinos and Singhalese, the average differences were small, and much overlapping occurred. As between these groups, however, and the Igorot and Negrito from the Philippines and a few reputed Pygmies from the Congo, the average differences were great, and the overlapping was small. Another rather similar test for intelligence, which was tried on some of these groups, gave them the same relative rank. The results of the test agreed closely with the general impression left on the minds of the experimenters by considerable association with the people tested. And, finally, the relative size of the cranium, as indicated, roughly, by the product of its three external dimensions, agreed closely in these groups with their appearance of intelligence, and with their standing in the form test. If the results could be taken at their face value, they would indicate differences of intelligence between races, giving such groups as the Pygmy and Negrito a low station as compared with most of mankind. The fairness of the test is not, however, beyond question; it may have been of a more unfamiliar sort to these wild hunting folk than to more settled groups. This crumb is, at any rate, about all the testing psychologist has yet to offer on the question of racial differences in intelligence.

In the absence of first-hand study of the mental powers of different races, folk psychology resorts to a comparison of their civilizations and achievements. This is the method by which we habitually compare the intelligence of individuals, judging capacity by performance, the tree by its fruits; and such judgments, though subject to occasional error, are probably in the main reliable. Why should we not extend the method to the comparison of groups, and say that a group possessing a high civilization has probably a high average intelligence, while a wild savage race is mentally poorly endowed? The first difficulty in employing the method is to obtain a just estimate of the cultures to be compared. First impressions regarding alien folk, derived from the reports of travelers, are usually wide of the mark. Only the patient and prolonged labors of the ethnologist can inform us as to what a tribe does and thinks; and where such studies have been made, it is found that a backward culture, such as that of the natives of Australia, has much more substance, and affords much wider scope for mental activity, than the early reports indicated.

The difficulty of inferring the mental endowment of a group from its stage of culture is well brought out by applying this method to the comparison of different epochs in the history of a nation. German culture to-day is much advanced from the days of Cæsar; shall we infer that the mental endowment of the Germans has advanced in like measure? Biologically, the interval, measured in generations, is not long, and from all biological considerations it is improbable that any advance in mental endowment has occurred. The difference in material civilization does not mean that

the German of to-day is, on the average, gifted with more native inventiveness or business ability than his ancestors sixty generations ago. The difference in the arts and sciences does not mean that the German of to-day is naturally more studious, or scientific, or musical. The more settled condition of society does not imply greater native capacity for industry or government. The disappearance of old superstitions does not imply that later generations were born without the tendencies to superstition which characterized their fathers. We are still not many generations removed from witchcraft, curses, magic and the like savage beliefs and practises, and we can not reasonably believe our recent forefathers to have been naturally more savage than we are. When, for psychological purposes, we compare the culture of Europe with that of Africa, we should not leave out of account the Children's Crusade, or the Inquisition, or the Wars of the Roses. And if we attempt to use the state of civilization as a measure of racial intelligence, we must somehow adapt the method so that it shall give the same results, whether earlier or later stages in the culture of a group be taken as the basis for study.

In reality, the civilization possessed by a generation can not be used as a measure of the intelligence of that generation any more than an individual's property can be taken as a measure of his business ability. The greatest part of the civilization of a generation is bequeathed to it, and only the increase which it produces can be laid to its credit. If we could compare the rate of progress in different groups, this might serve as a measure of intelligence; and certainly some peoples are more progressive than others. Before adopting such a test, we should understand the mechanism of progress—a matter which belongs only in part to psychology.

Progress depends first of all on human inventiveness—so much will probably be allowed. Under the head of inventions should be included, not only mechanical devices, but works of art and government, business enterprises and changes in custom, so far as any of these demand originality in their producers. Science and all increase in knowledge should also be included, since the process of discovery differs but little from the process of invention. In both the essential mental act seems to be a bringing together of things that are found apart, or a pulling apart of what occurs together. In fact, both of these processes, the combining or associating, and the analytic or discriminating, go on together, since we see something new in a thing when we are reminded by it of something else and different. There is a suggestion of the accidental in all invention, since it depends on "happening to notice something," or "happening to be reminded of something." You can not be sure that a person will make a discovery, even when you supply him with the elements which would combine to produce it. Oftentimes, in reading the history of scientific progress, one is surprised that a certain discovery was not made by some man who had apparently everything before him to lead to it. Invention is of the nature of a spontaneous variation, and this accidental character is very important in understanding the mechanism of progress.

On the other hand, since one can not be reminded of things entirely unknown, invention depends on previously acquired knowledge, and the inventiveness of an individual must take a direction prepared for him by the social group among which he lives. A large share of the inventiveness of the Australian natives seems to be

directed into the channels of magic and ceremony. The finished product of one mind's inventiveness becomes raw material for another, and invention of all sorts is distinctly a cooperative enterprise.

Invention is said to be mothered by necessity; and the proverb is no doubt true in the main, though curiosity and experimentation belong among the play instincts. But, in any case, the necessity must not be too dire, for some degree of leisure is demanded if anything novel is to be thought of, and rapid progress is only possible when individuals can be allowed to accumulate the special knowledge which may serve as the raw material for their inventive activity. Divisions of labor, guilds, universities, legislatures, investigating commissions, permanent research bureaus—each of which is, genetically, a series of inventions—are dependent for their existence on a certain degree of leisure, while they in turn provide more leisure and opportunity for further advance. They are inventions which accelerate the progress of invention. There are thus many factors besides the intellectual endowment of a generation which go to determine the progress which it shall make. The spur of necessity, the opportunity afforded by leisure, the existing stock of knowledge and inventions and the factor of apparent accident or luck have all to be considered.

A still further factor is the size of the group, which is deserving of renewed attention. Not only does a large group afford more opportunity for division of labor and special institutions for research, but the biological consideration already mentioned should be emphasized. The contributions to progress of the average man are small, the inventions of moment arising in the brains of a small fraction of the group. A large group provides a greater number of inventive minds, and it is rather the absolute number of such than their proportion to the whole population that determines the progress of invention within a group. The "group" needs to be redefined from the point of view of invention. If knowledge and inventions pass back and forth between two nations or races, the inventive minds of both are brought into cooperation, and the group is by so much enlarged. From the point of view of progress, however, the question is not simply how many inventive minds are brought into cooperation, but how free and rapid the communication is between them. At the present time, a discovery originating anywhere in Europe or its colonies is quickly known by specialists in all parts, and may promptly fructify the mind of a distant investigator, leading to a fresh advance. The invention of printing and of rapid means of communication must be credited with a large share of the rapid progress which has been made by the last few generations. Much also must be credited to the invention of steam power, which has vastly multiplied the size of the European group, in an economic sense, and set free many minds of ability for productive thinking. The very idea of the advancement of science and invention as an end to be striven for is to be classed as an invention, and a rather recent one; and it too is an accelerator.

Such considerations provide at least a partial explanation of the different rates of progress in different generations, and among different races. Whether they explain everything could perhaps only be determined by a drastic experiment, which it will do no harm to imagine, though the question will never be settled in this convincing way.

Let two or more habitats, isolated from each other and from the rest of the world, and as nearly as possible alike, be chosen,

and peopled by two equal groups of children, selected from some highly civilized nation, and so selected as to represent fairly the distribution of mental and physical traits among that nation. For every individual in the first group, let there be a practically identical individual in the second. Let these groups of children be introduced into their new homes in infancy, and, by some quasi-miraculous means, let them be all preserved to maturity, and then let them, and their descendants, be left entirely to their own devices, without fire, or a language, or other modern improvements. To watch such a spectacle from afar would be thrilling, if not too pitiful. We can readily grant that the infant communities would begin at the very zero of civilization, and that their progress, for many generations, would seem excessively slow. But the real point of the experiment is to inquire whether these two equal groups, alike in numbers, in heredity and in environment, would remain alike, and progress at equal rates. Probably they would not. We must allow for a large element of chance in the mating of males and females within each group, and consequently for changes and inequalities in the distribution and correlation of traits—changes which need not alter the average of either group. We must allow for spontaneous variation in the offspring, another accidental factor by virtue of which a really inventive and effective individual, or conjunction of such, would almost certainly arise in one group earlier than in the other, and give the advance of one group an impetus which might be felt through many generations, and carry this group far ahead of the other. And we must allow also for the accidental factor in invention. Even though the genius of one group was paired by an equal genius in the other, it is improbable that both would invent the same things. One might invent a hunting implement, and the other a fishing implement; and by this accident the direction of development might be settled for each group. If we closed the experiment after a thousand generations, we should probably find two peoples of different languages, different customs, and cultures divergent in many respects. The supposed result may be taken as an assertion of the importance of accident in determining the destiny of peoples. Obscure causes are no doubt at work beneath the accidents, but we can not trace them, nor reasonably state them in terms of racial superiority and inferiority.

It would seem that size of groups, and accidental factors, exert so much influence on the rate of advance in civilization that differences of culture could possibly be explained without supposing the mental endowments of the races to differ. Whether the existing races of men do or do not differ in such a trait as inventiveness is another and more difficult problem, the settlement of which must be left to time and educational experiments. The experiments must be continued for several generations, in order to equate social traditions. Regarding the negroes of the south, I am informed by a gentleman who has spent twenty years in educating them that a distinct advance is perceptible during this period, especially among the children of educated parents. These have more educational ambition, enter school earlier and have less to unlearn. The educational experiment, as far as it has gone, thus shows that much time will be needed before a clear result is reached.

Meanwhile it may be allowed to add one more general consideration by asking whether causes of a biological nature can be seen to be at work in human history, such as would differentiate the races intellectually, and, in particular, such as to

raise up, in some part of the world, a race superior to the stock from which it sprang.

Natural selection has been suggested as such a cause. Life in the tropics, it has been said, is too easy to demand much inventiveness or forethought, but a migration to colder regions, where the banana does not grow, would make mental activity imperative, and select those individuals who were able to respond, so producing a superior race. There is a difficulty here, since we should expect natural selection to begin by lopping off the most poorly endowed fraction of the population, with the result, finally, that the lower range of intelligence should disappear from the higher races. The lowest grade of intelligence in Europe should accordingly be higher than the lowest grade in Africa. But this is probably not the case; the range of intelligence reaches as low in one as in the other. The distributions of intelligence in the two also overlap to quite an extent. Extensive experiment has shown that Africans can maintain existence in the temperate zone.

Sexual selection, or, more properly, mating customs, furnish a more promising factor. If a tendency could be detected in any population for the most intelligent members to mate with each other, the result would be, not indeed a raising of the average intelligence, since the less intelligent would also mate with each other, but an increase of the variability, and greater chance of the birth of very superior individuals. A caste system might operate in this way, since the founders of aristocratic families probably won admission to the caste partly by virtue of intelligence, and their descendants would tend, by heredity, to exceed the average intelligence of the population. Marriage confined to the caste would thus tend to mate superior individuals with each other, and might, in the course of generations, raise the upper limit of intelligence. Customs of mating within one's rank obtain among the aristocracy and royalty of Europe, and may have been a factor in increasing the number of superior intelligences. But too much can not be attributed to this factor, since the selection has been by classes, and not by individuals. Royalty, while marrying within its rank, has not usually chosen the most gifted individual available. Its selection has been relatively inefficient from the standpoint of royal eugenics. Certainly the upper reach of European intelligence has not been the result of breeding by castes; for, though royalty has indeed produced a disproportionate number of high intelligences, equally able individuals have, as a matter of fact, risen from humble birth. Moreover, marriage in all parts of the world is largely governed by considerations of family standing and wealth, so that the same sort of influence toward variability is everywhere operative. The dead level of intelligence, which is sometimes supposed to obtain among backward races, is not borne out by psychological tests, since individual differences are abundantly found among all races, and, indeed, the variability of different groups seems, from these tests, to be about on a par.

Selection by migration is also to be considered. When individuals leave their group and go to a new country, it would seem that those who emigrate must differ, on the average, from those who remain behind. An adventurous and enterprising spirit, perhaps, would be characteristic of the emigrants, and so of the new people which they helped to form. On the other hand, the ne'er-do-well and the criminal might also be induced to emigrate. The selective influence of migration would not be all in one direction, and the net result could not easily be predicted. Since we are now witnessing, though little compre-

hending, this process of migration as it contributes to form a people of the future, information regarding the kind of selective influence exerted by migration would have a practical value. Wisdom would dictate that the nation which is in process of formation should exert some selective influence on its own account, but, from all the facts in hand, the part of wisdom would be to select the best individuals available from every source, rather than, trusting to the illusory appearance of great racial differences in mental and moral traits, to make the selection in terms of races or nations.

R. S. WOODWORTH
COLUMBIA UNIVERSITY

SCIENTIFIC NOTES AND NEWS

THE Geological Society of London has awarded the Wollaston medal to Professor W. B. Scott, of Princeton University, "in recognition of his many valuable contributions to our knowledge concerning the mineral structure of the earth, and especially in relation to the tertiary mammalia and tertiary stratigraphical geology of North America and Patagonia."

AT the recent meeting in Boston, Dr. George A. Piersol, professor of anatomy, was elected president of the American Association of Anatomists.

DRS. CHARLES H. FRAZIER, John H. Musser, David L. Edsall and A. C. Abbott have been appointed by Provost Harrison, of the University of Pennsylvania, managers of the Phipps Institute for the purpose of entering upon the construction of the new building with the money contributed by Mr. Phipps.

MR. A. F. WOODS left Washington on January 23 to take up his new duties at the University of Minnesota. On the evening of January 22 he was tendered a reception by the Bureau of Plant Industry, at which time a silver service was presented to him in commemoration of his long service in the bureau. Addresses were made by Assistant Secretary Hays, Mr. D. G. Fairchild and Dr. Erwin F. Smith.

A DINNER in honor of Professor James Truman, emeritus professor in the University of Pennsylvania Dental School, was given at the Waldorf-Astoria, in New York City, on January 23.

ON the occasion of the inaguration of Dr. H. H. Apple, as president of Franklin and Marshall College, on January 7, the degree of LL.D. was conferred on Dr. Edgar F. Smith, vice-provost of the University of Pennsylvania and professor of chemistry, and on Dr. J. H. Musser, professor of clinical medicine of the University of Pennsylvania.

DR. ALBERT LADENBURG, professor of chemistry at Breslau, has been elected a corresponding member of the Paris Academy of Sciences.

DR. OTTO N. WITT, professor of industrial chemistry in the Berlin School of Technology, has been made an honorary member of the Royal Institution, London.

MR. T. CASE, Waynflete professor of moral and metaphysical philosophy and president of Corpus Christi College, Oxford University, has resigned his professorship.

DR. C. O. TOWNSEND, pathologist in charge of sugar beet investigations, Bureau of Plant Industry, has resigned from the government service. He left Washington on January 17, for Garden City, Kansas, where he has accepted a position as consulting agriculturist for a large sugar beet company.

PROFESSOR F. W. MORSE, formerly chemist of the New Hampshire Experiment Station and professor of organic chemistry in the New Hampshire College, has been engaged temporarily as research chemist at the Massachusetts Agricultural Experiment Station.

THE board of directors of the Metropolitan Life Insurance Company has appointed Dr. Jay Bergen Ogden, to be assistant medical director of the company.

DR. HANS HALLIER, conservator of the Royal Herbarium at Leyden, has been visiting the botanical gardens of the United States.

Professor N. E. Gilbert, of the department of physics of Dartmouth College, has gone to study at Cambridge University during his sabbatical year.

Dr. Chauncey Juday, lecturer in zoology at the University of Wisconsin, has gone to Central America, where he will spend a month studying lakes, particularly those formed in volcanic craters, in Guatemala.

An archeological expedition from Princeton University will leave early in February. Professor Howard Crosby Butler, who has led three expeditions to Syria, will sail on February 8 for Constantinople, where he will perfect the arrangements for the new expedition, which will work in Asia Minor.

Mr. Eckley B. Coxe, Jr., of Philadelphia, founder of the Eckley B. Coxe, Jr., expeditions into Nubia of the University of Pennsylvania, has been made president of the archeological department of that university.

Dr. W. A. Murrill, assistant director of the New York Botanical Garden, has sailed for southern Mexico, to continue his studies of tropical fungi. He is accompanied by Mrs. Murrill.

At a meeting of the American Philosophical Society, to be held on February 4, Professor Francis G. Benedict, of the Carnegie Nutrition Laboratory, Boston, will read a paper on "The Influence of Mental and Muscular Work on Nutritive Processes."

Professor James F. Kemp, of Columbia University, gave a lecture before the geological department of Colgate University on the evening of January 28. His subject was "The Physiography of the Adirondacks."

At the regular monthly meeting of the Oregon Academy of Sciences held on January 15 an address was delivered by Mr. Ira E. Purdin on "Local Geological Conditions." The annual meeting of the academy will be held on March 11 and 12.

Monday evening lectures before the College of Liberal Arts of Northwestern University have been given as follows:

December 20—"Our Present Knowledge of Human Lineage" (illustrated), by Professor William A. Locy, Ph.D., Sc.D.

January 10—"Some Alaskan Glaciers" (illustrated), by Professor Ulysses S. Grant, Ph.D.

January 24—"From Galileo to Kelvin, the Rise of Modern Physics," by Professor Henry Crew, Ph.D.

January 31—"Problems of Modern Astronomy" (illustrated), by Professor Philip Fox, M.S., director of Dearborn Observatory.

Professor Hugo Münsterberg, of Harvard University, delivered, on January 21, 1910, the second of the series of lectures being given during the college year by the Omega chapter of the Sigma Xi Society, at the Ohio State University, Columbus, O. He spoke on "The Psychologist in the Courtroom."

The fortieth anniversary of the founding of the American Museum of Natural History will be celebrated on the afternoon of February 9, at which time a statue of Morris Ketchum Jesup will be unveiled. The commemoration and presentation address will be made by Mr. Joseph H. Choate.

The Pennsylvania State Breeders' Association and Dairymen's Association held memorial services for Professor Leonard Pearson, at the University of Pennsylvania, on the evening of February 2. Dr. James Law delivered the principal address.

A portrait of Dr. Nathaniel Chapman, professor of medicine in the University of Pennsylvania from 1813 to 1850, was presented to the College of Physicians on January 5. The presentation was made by Dr. S. Weir Mitchell on behalf of Mrs. Henry Caldwalader Chapman in memory of her husband, the late Dr. Henry C. Chapman.

Dr. James F. Conneffe, assistant in the department of bacteriology, Ohio State University, Columbus, Ohio, died on Thursday, January 20, of typhus fever. Dr. Conneffe went to Mexico as a member of an expedition in charge of Associate Professor E. F. McCampbell, of Ohio State University, and contracted the disease while in Mexico. Dr. Conneffe was a graduate of the Medico-Chirurgical College of Philadelphia in 1906.

Probate has been granted of the will of Sir Alfred Jones, of whose benefactions to public objects some particulars have already been published. The estate is valued at £674,259. After some legacies to relatives and employees, Sir Alfred left the residue of his estate, which will probably exceed £500,000, for such public purposes and objects in England, or in any British possession on the west coast of Africa as his trustees may think fit. Five suggestions as to the purposes to which the money might be applied are made, the first three of which are: (*a*) The technical education of natives on the west coast of Africa; (*b*) the advancement, benefit or support of education or science; (*c*) original research of all kinds into the cause of diseases on the west coast of Africa.

The executive committee of the National Education Association announces that the forty-eighth annual convention will be held in Boston, Mass., July 2 to 8, 1910.

The third International Congress of School Hygiene will be held at Paris, August 2–7, 1910. The importance of the subject to which the congress pertains, and the interest manifested in the first congress held at Nuremburg in April, 1904, and in the second of the series held at London in August, 1907, justify the belief that the forthcoming congress will be largely attended, and that its deliberations will materially advance the efforts for the improved hygienic condition of schools and the physical well-being of school children. M. Duomergue, the minister of public instruction in France, has accepted the honorary presidency of the congress. The president is Dr. A. Mathieu, president of the French Association of School Hygiene, Paris, France. The medical inspector of schools, Paris, Dr. Dufestel, is the general secretary of the executive committee of the congress.

Funds have been raised by public subscription for the establishment of an astronomical observatory at Kamuki, Honolulu, to be used in the first instance for observations of Halley's comet. The observatory, however, will be permanent and under control of the College of Hawaii.

The Harvard Seismographic Station in the geological section of the university museum has been open to inspection by officers of the university and their families. Professor J. B. Woodworth or a representative has been present to explain the seismograph and to show the records obtained of distant earthquakes. During this week the station has been open to inspection by students in the university and their friends. The Students' Meteorological Observatory (on the roof of the Geological Museum), which is now partially equipped with instruments, has been open for inspection on the same days. Professor R. DeC. Ward or Mr. William G. Reed, Jr., has been present to explain the use of the instruments. The new model of the temperatures of Boston, recently placed in the museum exhibition rooms, were shown at the same time.

The council of the Royal College of Surgeons, in view of the fact that women medical students are to be admitted to the college diplomas in January, adopted a recommendation that the London and Edinburgh schools of medicine for women be added to the list of medical schools recognized by the two royal colleges.

From February 7 to 12 two seed and soil special trains will be run over the Vandalia line from St. Louis to Terre Haute and thence to Peoria. From Peoria the same party will travel on a train over the Toledo, Peoria and Western Railroad from Sheridan to Warsaw—from Indiana state line to the Mississippi. The speakers will be provided by the Agricultural Experiment Station of the University of Illinois and the trains by the railroad companies.

The Journal of the American Medical Association states that the Philadelphia County Medical Society had decided to establish a medical library for the use of its younger members. The library committee was authorized to contract with the Free Library of Philadelphia for the reservation of alcoves in the different branches throughout the city for medical books and publications. These works are to be selected by a committee composed of

Drs. James M. Anders, M. Howard Fussell, Herman Allen and Edward E. Montgomery. An initial appropriation of $300 was made by the society for the purchase of books and journals.

The desirability of establishing an international scale for the comparison of observations in solar radiation has led Mr. C. G. Abbot, director of the Smithsonian Astrophysical Observatory, to construct a standard "pyrheliometer." This instrument, tested by him both in Washington and at Mount Wilson in California, has been found to yield satisfactory results. Accordingly, a limited grant from the Hodgkins Fund of the Smithsonian Institution was made for the construction of four of these silver disk pyrheliometers. These have now been completed and are about to be sent to investigators in widely separated localities for use in obtaining constants. The first will be sent to M. Violle, who is chairman of the committee on solar radiation of the Solar Union, and by him will be placed in the meteorological station established by the French government on the Pic du Midi in the Pyrenees in the south of France. The second will go to M. Chistoni, of the Physical Institution in Naples, and will be sent to the observatory on Mount Vesuvius.

This government has received through the customary diplomatic channels, an announcement of the Official Exhibition of Art to be held at Buenos Aires, Argentine Republic, to commemorate the first centenary of the independence of the country. This exhibition will be opened on May 25, 1910, and will be continued until September 30, or later should the executive committee so decide. Full details with reference to the conditions of participation in the exhibit may be obtained by addressing El Senor Comisario General, Exposicion Internacional de Arte del Centenario, Cangallo 827, Buenos Aires, Republica Argentina.

UNIVERSITY AND EDUCATIONAL NEWS

Charitable and educational institutions received $162,000 by the will of Mrs. Frances E. Curtiss, of Chicago. Among the institutions benefited are Williams College, Williamstown, Mass., $25,000.

Cooper Medical College, San Francisco, has received a bequest of $5,000 by the will of the late Mrs. Myrick.

Plans are under way for the merger of the Jefferson, Medico-Chirurgical and Polyclinic Medical Colleges of Philadelphia and their connection with some university as its medical department.

The trustees of Syracuse University have recently voted in favor of the proposition to establish a College of Agriculture and Forestry in that institution. As a preliminary step there will be organized out of facilities already available an agricultural group and a forestry group of studies drawn especially from the departments of botany, chemistry, engineering, geology (including meteorology) and zoology. These courses will be open to election with the next collegiate year. Temporarily, the work of organization is to be under the direction of Professor William L. Bray, of the department of botany.

The total number in attendance last year for the two weeks' courses in agriculture and for the Corn Growers' and Stockmen's Conventions at the University of Illinois was 775. That number will be more than surpassed this year. More than 700 have already been registered, of whom 115 are women. The lectures are being given not only by men of the college, but by men of prominence from different parts of the state.

President Schurman, of Cornell University, said in a recent address: "I should like most to see at Cornell a score of research professorships with salaries, say $7,500 each, which would call for a capital of some $3,000,000 or $4,000,000, a really small amount in this age of American multi-millionaires."

Dr. Louis A. Klein, appointed last year professor of pharmacology and veterinary medicine, has now been made dean of the veterinary department of the University of Pennsylvania, to fill the vacancy occasioned by the death of Dr. Leonard Pearson.

Robert Bruce Brinsmade, B.S. (Washington University), E.M. (Lehigh), has accepted the chair of mining engineering at West Virginia University, replacing Henry Mau Payne, who has gone into other lines of work.

Mr. O. T. Jones, of the Geological Survey of England and Wales, has been appointed lecturer in geology and physical geography in University College, Aberystwyth.

Mr. H. J. Seymour, B.A., of the Geological Survey of Ireland, has been appointed professor of geology in University College, Dublin.

DISCUSSION AND CORRESPONDENCE

THE GREEN BUG AND ITS NATURAL ENEMIES

Professor Woodworth has very kindly sent me in advance a copy of his review of "The Green Bug and Its Natural Enemies." The views advanced by him are interesting and his interpretations somewhat out of the usual order.

1. He does not understand why data from the experimental laboratory studies were not used to show the potentiality of the parasite, *Lysiphlebus tritici*, over the green bug, *Toxoptera graminum*. No attempt was made to use the data in that way, since the contest between the two forms took place, not in the experimental laboratory, but under natural conditions in the open, over territory from central Texas northward through Oklahoma to central Kansas. Accordingly, it was stated (page 135), "The average number of green bugs killed by a single parasite under natural conditions is probably much larger than the above figures show," and reasons were there given for this opinion. Since that time corroborative evidence on this point has appeared as follows: "The female *Lysiphlebus* is even more prolific than the female *Toxoptera*. Mr. Phillips has found females which had upwards of four hundred eggs in their ovaries and Mr. Kelly has reared in some cases 206 individuals from a single mother *Lysiphlebus*.[1]

Obviously, then, figures or tables, such as prepared by the reviewer, based on data obtained under artificial conditions, would not form a safe basis for conclusions upon the outcome of such a struggle in the natural environments of the contestants.

However, since the reviewer has placed special stress upon the value of his tables it should be noted, as showing their bearing upon the laboratory experiments, that he takes the minimum period, five days, for development of the green bug and considers that as the average. That is, among 140 green bugs reared in laboratory under daily observation, four, or 2.8 per cent., gave birth to young on the fifth day, and this percentage he rates as the average. As a result he obtains 95,571 progeny for one green bug in thirty days, whereas the author, using the average summer rate, seven days, of development for 80 green bugs reared in laboratory under daily observation, obtains for the same period 15,794 (page 95)—a difference of 79,777 on the first basis of comparison. As to the parasite, the reviewer takes the average rate (page 7 based on results of several observers) of development of parasite in the open field, seven days, for his computation on the parasite.

That is, the behavior of 2.8 per cent. of the green bugs observed in the laboratory and the behavior of the average of all parasites observed in the open, are the factors which he uses to compute the potentiality of the parasite. Obviously, basal factors so unlike in quantity and conditions furnish no reliable foundation for comparisons from which to deduct safe conclusions. Furthermore, these factors are not representative of the data from which they are supposed to be taken.

Consequently, the subsequent computations and deductions upon his table as brought out by the reviewer, unique in themselves, would not seem to require further consideration here.

The statement of the author regarding the outcome of the struggle between the parasite and its host was not based upon deductions from the experimental laboratory data, but from the records of continuous field observations made during the entire time of the struggle by eight different reliable observers. The seven from the university were stationed from central Oklahoma to northern Kansas, as

[1] Circular No. 93 rev., p. 15, U. S. Dept. of Agric., B. of Ent., June 23, 1909.

shown by pages 13 to 30 of the bulletin. The eighth, Agent Sanborn, of the Federal Bureau, who had been working by assignment on this problem for a year previous, was present at the original outbreak in Texas and made personal observations back and forth from central Texas through Oklahoma to central Kansas.

The pertinent portions of these various field observations are to be found on the pages just cited, and all agree without qualifications that *Toxoptera graminum* had been vanquished by *L. tritici*. Moreover, every entomologist whose observations on this undue multiplication of *T. graminum* have since been published agree on this point.

From the information, then, at hand bearing upon the statement, "That this parasite not only controlled, but in many cases practically exterminated, the green bug last season no one questions," it would seem that, with the exception of the reviewer, this statement maintains.

2. The reviewer suggests the probability of the disappearance of the green bug being due to meteorological influences and cites from the report to show that climatic conditions inimical to the green bug do arise. Such conditions do arise, but, as Glenn has shown later in this report (pages 176 and 180), it is the extremes of summer and winter temperature that affect the green bug, while the struggle between these forms took place and was decided during April and May, within which time, as the records show, no such inimical climatic conditions existed.

3. On pages 150–155 of this bulletin it was shown in the laboratory experiments that *L. tritici* did parasitize certain aphids other than *T. graminum*. On page 156 the original description of *L. tritici* Ashmead is published, in which appears, "Reared June 20, 1882, from wheat Aphis, *Aphis avenæ*." There does not, then, seem to be any evidence in this bulletin to support the reviewer's inference, that, "He [the author] considers the parasite to belong particularly with this species of Aphid."

4. In referring, however, to whether *Lysiphlebus* maintains a general distribution on these other hosts the reviewer calls attention to a pertinent question. The author believed and so stated many times during this outbreak prior to the middle of April, that this parasite existed quite generally over the country, supposedly on other aphid hosts. The author's opinion was modified during April by the cumulation of the following data:

(Pages 31 and 32.)

(*a*) The green bug was present in Kansas in December, 1906.

(*b*) During the first two weeks of April, eight widely separated localities throughout the wheat area of the state showed parasites present in but one place, and subsequent examination proved that to be a spot of very small area.

(*c*) During the same period of April an expert from the Federal Bureau of Entomology, sent here to study the situation, examined wheat fields in nine different parts of the state (Kansas) and found those places free from parasites, except at one point on the southern border, where, he states, "they are beginning to appear."

(*d*) Field experiments showed that parasites were absent until introduced.

(Pages 29 and 30.)

(*e*) Sanborn reported that *T. graminum* had continued to multiply during December and January over a comparatively large area of northern Texas under conditions favorable to the existence of the parasite and yet no parasite had appeared.

Then, later in the season, further evidence tended to confirm the opinion that *T. graminum* did not maintain a general distribution on other aphids: First, early in June, after weather favorable to both the artificial and natural distribution of the parasites, a conservative, trained observer found a large area in the northern part of the state (Kansas) where green bugs were present, but parasites, with one possible exception, only where introduced. Second, a serious outbreak of the green bug was reported from Washington, D. C., unattended by the parasite, and this at the close of July, a season most favorable for the activities of the parasite (page 32).

Since the meteorological conditions of the spring of 1907 were unusual, the author was

still of the opinion that in normal years the parasite would, in all probability, maintain a general distribution (page 26). During the spring and summer of 1909 a notable exception to this opinion existed in southwestern Oklahoma. Here the green bug was abundant over about one hundred square miles. This area was examined, first by a representative from the federal bureau about the middle of April and then by a member of the entomological department of the university of Kansas a month later, and neither of these entomologists found any evidence of the presence of the parasite. Reliable reports subsequently made to the author showed the green bugs present and the absence of the parasite during the entire growing season and this in a locality where parasites were superabundant two years previous and in a climate favorable to the existence and natural distribution of the parasite.

These are the evidences upon which the opinion was based that this parasite does not maintain a general distribution.

5. What the reviewer says regarding the Australian lady bird in California is important. The only reference to this insect in the bulletin is in connection with a historical summary of entomological endeavor in the control of one insect by the use of another. Since this lady bird is not referred to in the discussion of the green-bug problems, there does not appear to be anything to show that the behavior of this lady bird was used as corroborative evidence to strengthen any conclusions regarding the green bug and its parasite.

S. J. Hunter
Department of Entomology,
University of Kansas

GAMETOGENESIS OF THE SAWFLY NEMATUS RIBESII. A CORRECTION

In the *Quarterly Journal of Microscopical Science*, Vol. 51, 1907, p. 101, I described observations on the gametogenesis of *Nematus ribesii*, some of which subsequent work has shown to be erroneous. Since my statements have been quoted in several recent papers, I think it necessary to correct the mistakes as far as possible, although I have not yet reached a satisfactory solution of the phenomena. The errors arose partly through misinterpretation of the phenomena observed, and partly through imperfect fixation, for I find that, unless the material is very accurately fixed, the chromosomes tend to adhere together and give the appearance of a smaller number than the true one. The same cause has led other observers to make similar mistakes.

Reinvestigation of *Nematus* shows, in the first place, that there is only one division of the spermatocytes; the first division described in my paper is not a true mitosis, but is probably comparable with the abortive division observed in the spermatogenesis of the bee. I have not yet been able to determine the chromosome number with certainty. In the spermatogonia the number appears to be about sixteen, and that in spermatocyte mitoses about eight, but if eight is the true reduced number, the occurrence of sixteen in the spermatogonial mitoses of larvæ derived from parthenogenetic eggs is unexplained. In the bee, and as I find, also in a cynipid (to be published shortly), the spermatogonial number is the same as that of the spermatocytes.

I have not yet obtained fresh material for reinvestigation of the maturation of the egg, but the results of my recent work on the spermatogenesis make it clear that my observations on the chromosomes in the polar divisions also require revision.

But the behavior of the chromosomes in *Nematus ribesii* is so difficult to follow that it is possible that the true interpretation will be obtained only by the discovery of some nearly related species in which they are more clearly distinguishable.

Leonard Doncaster
University of Birmingham, England,
November, 1909

MOUNTAIN AND VALLEY WINDS IN THE CANADIAN SELKIRKS

To the Editor of Science: Report has been brought from British Columbia by Mr. C. T. Brodrick, of Harvard University, of an interesting case of the daytime descent of air

currents in mountain valleys. The fact of the nocturnal descent of air on mountain sides and along the floors of mountain valleys is familiar, and in some cases a deepening of the current during the night has been noted. The present report describes the method of occurrence of the lateral drainage only. The observer found that during the daytime, provided the sun shone, a distinct set of the air toward the valley bottoms was noticeable in the shadows of cliffs, while in the sunlight no movement was discernible. One case, where a vertical cliff cast a well-defined shadow, showed that by going even so short a distance as twenty-five feet, one moved from uncomfortable heat into a cooling breeze. This descent of air in the shadows was undoubtedly due to a cooling similar to the more often observed nocturnal phenomenon, though on a very small scale.

A similar control over *nocturnal* winds was noted by the writer a few years ago near the foot of the Illecillewaet Glacier, in the Canadian Selkirks. The valley of the Illecillwaet River, which flows northwestward from the glacier, is very steep walled. This, with the presence of the ice, affords ideal conditions for nocturnal downcast winds. About sunset on the day in question, the writer was standing near the foot of the glacier, but somewhat upon the east side of the valley. The air was perfectly calm, and the temperature in the full sunlight gave no indication of the presence of the ice. The west side of the valley was already in shadow. As the edge of this shadow crossed the valley floor, a distinct movement of foliage within the shadow became evident. The zone of movement widened, keeping pace with the advance of the shadow; and as the edge of the latter passed the observer on its way up the east wall of the valley, the edge of the zone of foliage movement lagged a hardly perceptible distance behind, and was seen to move up the slope to the limit of the bushes. Possible movement beyond this point was rendered invisible by the distance and character of vegetation on the higher slopes. Almost at the instant of the passing of the shadow edge, a gentle puff of cold wind down off the glacier announced the beginning of the nocturnal descent of air. Half an hour later, at the hotel some distance down the valley, the night wind was already blowing moderately and the temperature had dropped many degrees.

It is improbable that the upper limit of foliage movement indicated the depth of the down-valley current in "mid-stream." The rapidity of ascent of the shadow would call for the sudden beginning of movement of a mass of air so large that it could not possibly have been cooled thus quickly throughout. Instead, the upper limit of a relatively thin sheet of cooling air which was moving more or less directly toward the valley bottom, was indicated.

Observation may prove that this lateral movement, while showing near its upper limits a fairly direct downward course, turns more and more obliquely down the valley under the influence of the drag of the air-stream proper. Careful study might also show whether the surfaces of such down-valley currents assume the slight convexity noted in the case of water-streams, or whether the constant lateral accessions of air tend to produce a diminishing concavity of surface as the stream slowly deepens during the night.

B. M. Varney

Harvard University,
January 6, 1910

SCIENTIFIC BOOKS

Outlines of Chemistry: A Text-Book for College Students. By Louis Kahlenberg, Ph.D., Professor of Chemistry and Director of the Course in Chemistry in the University of Wisconsin. New York, The Macmillan Co. 1909. Pp. vii + 548. $2.60 net.

In a clear and interesting style the author here presents such a course in elementary chemistry as was almost universally taught a generation ago and still keeps its place in many of our largest institutions of learning. Professor Kahlenberg has accomplished his purpose with a high degree of success, but we may nevertheless inquire with all seriousness whether this purpose is consistent with the

most efficient training of chemists as technicians and as thinkers.

Chemistry, it must be admitted, is still far from being an exact science, but an enormous stride has been made in this direction during the last few decades as a result of the work of such men as Guldberg and Waage, Gibbs, van't Hoff and Arrhenius. The exact laws and theories developed during this period constitute powerful weapons of research which are the birthright of the new generation of chemists. To withhold all knowledge of these illuminating ideas even in the most elementary course in chemistry is unjust to the student and to the science.

If the author had omitted all theory from his book and made it frankly descriptive, there would be little to criticize and much to praise, but this volume contains fully as much of chemical theory as the average teacher would consider it desirable to introduce in a single course. However, the laws and theories with which the reader of Kahlenberg's book will become familiar are chiefly limited to those which had been accepted a generation or more ago.

It was to be expected from one holding Professor Kahlenberg's pronounced views that the great modern developments in the study of solutions, especially of aqueous solutions of electrolytes, would receive but scant attention, but other great advances in chemical theory suffer from an equal neglect. The important ideas of heterogeneous equilibrium introduced by Willard Gibbs, which have been brought into simple pedagogic form by various teachers, notably by Ostwald, are not only ignored, but statements are made which flagrantly violate all phase-rule doctrine. The student can not fail to acquire fundamentally erroneous conceptions from such a paragraph as the following:

Suppose a block of ice and one of common salt be placed in contact with each other; we note that the salt and ice gradually disappear, forming a brine. Evidently the brine has quite different properties from those of either the salt or the ice. Moreover, there was a marked change of temperature, in this case a cooling effect, as the salt and ice acted on each other. Furthermore, a contraction ensued, for the volume of the brine is less than the sum of the volumes of the blocks of ice and salt. Again, as a block of ice and one of paraffine, or one of salt and one of paraffine, for example, do not act on each other at all when brought into contact, it is clear that the action between ice and salt takes place because of the specific nature of the substances. Furthermore, it has been found that below —22° C. ice and common salt no longer act on each other, just as iron and sulphur do not act on each other at ordinary temperatures. Raise the temperature sufficiently in each case, and at a certain definite point action begins.

In this paragraph the author shows also his attitude towards the important subject of reaction velocity. His comparison of the eutectic point of salt and water with the "definite point" at which sulphur and iron begin to react might be regarded as a mere slip of the pen were it not for the fact that similar ideas are advanced in the discussion of ignition points and kindred phenomena. One of the most serious fallacies concerning reaction velocity is not only affirmed but italicized on page 23.

The rate with which a chemical reaction proceeds is proportional to the chemical affinity that comes into play.

If this were the truth we may be sure that none of us would be alive to announce it, for the affinity of our tissues for the oxygen of the air is enormous compared with that which comes into play in the majority of vital processes.

Other instances of too much theory might be cited. For example, the statements concerning the nascent state and the mechanism of oxidation and reduction processes are, to say the least, unproven. In discussing inorganic compounds frequent use is made of graphical formulæ of very questionable character. Mention is nowhere made of the simple gas laws, but an amazing polemic chapter is devoted to theories of solution and osmotic pressure.

The principle of mass action is given friendly though somewhat scant discussion. Owing to the author's unwillingness to adopt the ionic view, he has been unable to apply

this principle to the large number of phenomena in aqueous solutions which so well illustrate the laws of chemical equilibrium.

The student who depends upon this textbook may acquire a large number of useful chemical facts. He will be attracted by the lucidity and stimulated by the enthusiasm of the author, but he will nevertheless be seriously handicapped when in any field of chemical endeavor he enters into competition with men who are trained in the use of all the tools of modern chemistry. GILBERT N. LEWIS

MASSACHUSETTS INSTITUTE OF
TECHNOLOGY, BOSTON, MASS.,
January 20, 1910

Iagttagelser over Entoparasitiske Muscidelarver hos Anthropoder. Af I. C. NIELSEN. Copenhagen. 1909. Entomologiske Meddelelser, R. 2, Bd. 4 (1909), with 4 plates.

THE above paper consists of 110 pages in Danish of investigations of muscid-larvæ entoparasitic on arthropods, exclusive of careful explanations in both English and Danish of the plates and over five pages in English giving a summary of the more important results announced. It shows much painstaking work, and the author is to be highly commended on the very valuable results obtained.

After reviewing the greater part of the literature, eight species are treated in detail, descriptions and figures being given of the maggot stages and puparia, to which are added many data on host relations. The one great feature of the work is the establishing of definite characters in the pharyngeal skeleton of the eight species studied, whereby the maggot stages can be accurately determined. It is reasonable to suppose that the characters given by the author will hold good through a large part of the superfamily Muscoidea. Excellent figures are given of the pharyngeal skeleton in its different stages, and the author is undoubtedly correct in assuming that there are but three maggot stages in the majority of the Muscoidea. Some exceptions to this rule may yet be found, though it must be admitted that the probability of such is remote. Investigations carried on by the bureau of entomology at the gipsy moth parasite laboratory in Massachusetts indicate that much further study of the subject is needed.

The spiracles of the maggot, both anterior and posterior, have been carefully studied and figured by the author. The determinations of the eight species above mentioned were made with the aid of Mr. H. Kramer, the German specialist in Tachinidæ. I can only say that two of them, *Tachina larvarum* Linn. and *Carcelia gnava* Meig., are not the species handled by us under those names at the laboratory, and we have the authority of Drs. Kertesz and Handlirsch for our determinations. Nielsen's *larvarum* deposits maggots, while ours deposits eggs. As further evidence that we are right, we know that the American and Japanese species of *Tachina* deposit eggs. The anal stigmata of the puparia of our *larvarum* and *gnava* differ conspicuously from those figured by Nielsen under these names. These points only show the difficulty of arriving at uniform determinations in the Tachinidæ with our present knowledge; careful study and comparison of types, even of the most common species, must be made.

Another point of importance brought out in the paper is the fact that the chitinous funnel of the maggot is not an actual part of the latter's integument, but is formed to a large extent from the integument of the host. The author shows that this funnel is present in all three stages of the maggot of certain species, but we know that other species are without it in the first stage.

Doctor Nielsen is certainly mistaken in believing that *Compsilura concinnata* does not penetrate the skin of the caterpillar with its piercer at the moment of larviposition. Our investigations, including actual observation of the living flies and dissection of both flies and hosts, prove conclusively that such penetration takes place. There is a considerable group of species, both European and American, that have this habit. Mr. William R. Thompson has recently secured thorough demonstration of the fact with *concinnata* at the laboratory, thus verifying conclusions arrived at from a

study of the anatomy of the parts, supplemented by observation of the females and rearing of the species during three consecutive seasons.

A most interesting chapter is included on the economic value of Tachinidæ, in which it is shown that these flies, unaided by other parasites, have entirely wiped out considerable colonies of lepidopterous larvæ in Denmark.

It is greatly to be hoped that Dr. Nielsen, and other students as careful and painstaking as he, will carry on further investigation of the early stages of Muscoidea.

I have to thank Dr. L. O. Howard, chief of the bureau of entomology, for having an English translation of Dr. Nielsen's paper made for me. This translation was done by Mr. August Busck, and it is hoped that it can be published in the near future for the benefit of students not familiar with Danish.

C. H. T. Townsend
Gipsy Moth Parasite Laboratory

The Autobiography of Sir Henry Morton Stanley, G.C.B. Edited by his wife, Dorothy Stanley. Pp. xvii + 538. Sixteen photogravures and a map. Boston and New York, Houghton Mifflin Company. 1909. $5 net.

One of the greatest of modern geographers has called Henry M. Stanley the Bismarck of Africa. This was his due because of the great part he took in the solution of the many difficult problems of that continent.

The son of James Rowland, born in 1841, at Denbigh, in Wales, his early life was a succession of serious and discouraging struggles. In fact, nearly his whole life was marked by this struggle with his fellow men. Even after success had crowned him, there were always to be found those who not only doubted and opposed him, but did so to the extreme of malice.

From the time when he was cast off by his own people he may have been the child of fortune, but it was always hard to realize that such was the case; perhaps this early buffetting was the means of developing that self-reliance which was his marked characteristic through life. Neglected by his family, his early training in the poor-house certainly can not be considered as the most favorable condition for beginning a career.

The first chapters of this volume were prepared by Stanley himself, the latter portion of the work, however, is the kindly work of his talented wife, who has filled in with marked skill the blanks in his rather fragmentary journals by abstracts from his publications.

One is constantly struck during the perusal of the first part of the book by the intensely devout attitude of Stanley's mind, and his sincerity and singleness of purpose. His mental activity was curiously in contrast with his surroundings, and he was most fortunate in his early contact with Mr. Stanley, the man to whom he owed most of his serious convictions as well as his name. Would that there were more men capable and willing to throw such helpful and sturdy influences for good about the needy youth of to-day; whether it would be accepted by them or not is, of course, an open question. Stanley accepted them, however, and prospered under this guidance.

Thrown again upon his own resources by the death of his best friend, he soon became a wanderer, serving in the southern army, later a prisoner of war, then in the northern navy. At the close of the war his career as correspondent began, and he traveled extensively, inspiring confidence in his energy and capability until the New York *Herald* opened the door to his future work.

Of this work the estimate of the great Petermann, was "that he had done more than all the scientific travelers in Africa for eighty years previous, more than the Arabians for a thousand years, and that he had no equal among the 'discoverers' of the earth." This was high praise, but the physical exertions which won these words and brought him home a gray-haired man did not dampen his zeal, and when the time came to finish the work of Livingstone, he was ready for the task.

Stanley undoubtedly lived ahead of his time, but time has caught up with him, and the real

estimate of the man's work which has recently been formed by the calmer study of the unprejudiced, will only be helped by the appearance of this thoroughly good work. It is all that an autobiography should be. There is no self-laudation, no posing for effect, and no fulsome praise.

In an ascending scale we follow him through Turkey, the Levant and Abyssinia. During these campaigns he became famous for the accuracy of his work; and his energy in getting it to his publishers was so great that some of his competitors seemed inclined to doubt its authenticity until the more tardy reports verified his statements. In the following years, during the search for Livingstone, the war in Ashanti land and the search for Emin Bey, the description of the terrible difficulties encountered were undoubtedly the cause of the disbelief so frequently expressed with regard to his results. Stanley was not a scientific man, but his keen observation of facts and his conscientious performance of duty must over-balance many defects in this line. The pioneer work of the first man traveling along these lines of greatest resistance must have been savage work indeed, and demanded every ounce of vitality of the most capable explorer of his day, if not of any time, and the wonder is that so few mistakes were made.

Immediately upon his return to Europe he sought to make his work of practical value, and here again he encountered the wildest sort of antagonism. His success and his after life are matters of history and this volume records them in a most pleasant and readable manner.

WILLIAM LIBBEY

PROGRESS OF PALEONTOLOGICAL RESEARCH BY THE CARNEGIE INSTITUTE

GENEROUSLY supported by Mr. Andrew Carnegie, whose interest in paleontological research is well known, the Carnegie Museum of Pittsburgh has during the past year made many forward strides. The work of extricating from the matrix some of the skulls of the mammalia found in the summer of 1908 in the Uinta Basin by Mr. Earl Douglass was diligently prosecuted during the early part of 1909, and Mr. Douglass has published in the *Annals of the Carnegie Museum* a brief account of three new Titanotheres from the Upper Eocene. These three species represent only a few of the large number of interesting forms recovered by Mr. Douglass during the expedition of 1908. A number of fossil turtles apparently representing an equal number of species were also recovered from various levels. These have been partially prepared for study and will be submitted for description to a specialist in this group. The nearly perfect skeleton of *Moropus elatus* recovered during the explorations made in western Nebraska during the years 1906 to 1908 has been freed from the matrix and prepared for mounting. A monographic paper giving an account of the osteology of the animal is in course of preparation by the Curator of Vertebrate Paleontology. Nearly twenty skeletons, some of them absolutely complete and others approximately complete, belonging to two species of the cameloid genus *Stenomylus*, were recovered in 1908 and 1909 by Mr. O. A. Peterson. Several of these skeletons have been worked out from the matrix and two of them have been prepared as slab-mounts and are now on exhibition in the museum. A singularly perfect skeleton of a carnivore, revealing features common to the Canidæ and the Felidæ, and not distantly related to *Daphœnus felinus* Scott, has been extricated from the matrix and mounted for exhibition. A paper upon this specimen is in course of preparation by Mr. O. A. Peterson.

Mr. Earl Douglass since June has been busy making collections in various geological formations in Utah. In August he discovered three dinosaurs with the skeletons apparently completely articulated. Under the direction of the curator of paleontology he is spending the winter in Utah engaged in carrying forward the work of taking up the remains of these colossal animals. Mr. Douglass's camp is located at a considerable elevation, but he has, so far as possible, forti-

fied himself against the cold winter, and with his wife to supervise the domestic arrangements in camp, and three laborers to aid him, he is endeavoring to rapidly extricate the skeletons from the hard sandstone in which they are imbedded. He writes enthusiastically of his work, and in a recent letter says, "We have found what paleontologists have been searching for for the past forty or fifty years, skeletons of sauropod dinosaurs of huge size, apparently absolutely complete, every vertebra in position, and even the ribs in place—not removed more in any instance than two or three inches from the point where they articulate with the facets of the vertebræ." Every precaution is being taken to recover these specimens as they have been found. A photographic record is being kept of the position of every bone, and it is hoped that when the great undertaking is completed a very important addition will have been made to our knowledge of the osteology of the sauropod Dinosauria. One of the interesting features in this connection is the discovery of the sternal ribs, which never have hitherto been found in position in connection with the Sauropoda.

Dr. Percy E. Raymond has been during the past year carrying on extensive researches in the region of Pittsburgh, and has made valuable and interesting observations upon the strata of western Pennsylvania, upon which he will shortly publish, showing the existence of extensive marine faunæ at points where such deposits were hitherto not known to exist. He has also been successful in discovering some new species of invertebrates, as well as the remains of some vertebrates. His studies are calculated to throw great light upon the formations of the region, which have hitherto been only superficially examined.

Two replicas of the skeletons of *Diplodocus carnegiei* were prepared and in the fall of the year were presented, one to the Emperor of Austria, the other to the King of Italy. The first specimen is located in the Imperial Museum at Vienna, the second in the Museum of the Istituto Geologico at Bologna. These replicas were made at the expense of Mr. Andrew Carnegie and presented on his behalf to the Emperor and the King by Dr. W. J. Holland, who, with his assistant, Mr. Coggeshall, set them up. Dr. Holland was personally received by the Emperor of Austria, who conferred upon him the cross of an Officer of the Order of Francis Joseph, and conferred upon Mr. Coggeshall the cross of the Order of Merit, surmounted with the crown. The King of Italy has conferred upon Dr. Holland the cross of Commander of the Crown of Italy, and upon Mr. Coggeshall the cross of Chevalier of the same order. In recognition of Mr. Carnegie's generosity the authorities of the city of Bologna have sent to the library of the Carnegie Museum a complete set of the writings of Aldrovandi, in thirteen volumes in the original binding. The set is singularly beautiful and well preserved. The Istituto Geologico at Bologna has presented to the Carnegie Museum a series of beautiful specimens of the fossil fishes of Monte Bolca, which are being prepared for exhibition.

One of the interesting accessions to the paleontological collections of the Museum during the past year has been an enormous tusk of *Elephas columbi* Falconer, found on the banks of the Allegheny River in the suburbs of Pittsburgh. It was washed out during a freshet. It is nearly nine feet in length.

During the year a beautifully mounted skeleton of *Portheus molossus* Cope, fifteen feet in length, the most perfect in existence in any museum, has been mounted and placed upon the walls.

The vertebrate material obtained and accessed for the museum during the past twelve months is extensive, aggregating many hundreds of numbers, and the invertebrate material is even more extensive.

* * * *

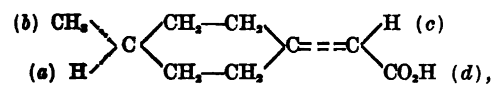
OPTICALLY ACTIVE SUBSTANCES CONTAINING NO ASYMMETRIC ATOM

The statement is frequently made that optical activity is due to the presence in the

molecule of an asymmetric atom—of carbon, nitrogen, sulphur, selenium, tin or silicon. In this form the statement is quite incorrect. As was shown by van't Hoff and Le Bel years ago, the optical activity originates in the enantiomorphous configuration of the molecule, which is conveniently recognized by the identification of a particular atom in the molecule as being asymmetric.

Experimental confirmation of van't Hoff and Le Bel's views has been recently furnished by Professors W. H. Perkin, W. J. Pope and O. Wallach[1] in an extremely valuable and lucid paper which they have contributed to the *Journal of the Chemical Society* (London).

In 1906, Perkin and Pope synthesized 1-methylcyclohexylidene-4-acetic acid,



which contains no asymmetric carbon atom. At first some doubt was expressed as to whether the acid did actually conform to the formula given, but subsequent work has amply confirmed its constitution and it has now been possible to resolve the acid into a dextro- and a lævorotatory modification, by repeated fractional crystallization of its brucine salt.

The racemic acid melts at 66°, the optically active acids melt at 52.5–53°; in absolute alcohol the specific rotatory power $[\alpha]_D$, is 81.4° and —81.1°, for the *d*- and *l*-acid, respectively. When mixed these acids regenerate the racemic acid of higher melting point.

Referring again to the formula given above, if the linkages represented by unbroken lines are supposed to occupy the plane of the paper and if those represented by broken lines lie in a plane perpendicular to the first, it will be observed that the plane which contains the continuous line bonds is not a plane of symmetry of the solid configuration, because the groups marked (*a*) and (*b*) are different. Similarly, the vertical plane mentioned above is also not a plane of symmetry, because the groups (*c*) and (*d*) are of different composition. In short, even when the usual tetrahedral symmetrical configuration is attributed to methane derivatives, the relatively simple acid formulated above is found to possess neither planes, axes nor a center of symmetry, and it is this which determines the enantiomorphism of its configuration.

The original paper will richly repay perusal; it is written in the clear and interesting manner characteristic of Messrs. Perkin and Pope's communications, and it contains a most instructive account of the great experimental difficulties which had to be overcome before this most important work could be brought to a successful issue.

J. BISHOP TINGLE
MCMASTER UNIVERSITY,
TORONTA, CANADA

[1] *Jour. Chem. Soc.*, 95, 1789, 1909.

INCOMES OF COLLEGE GRADUATES TEN YEARS AFTER GRADUATION

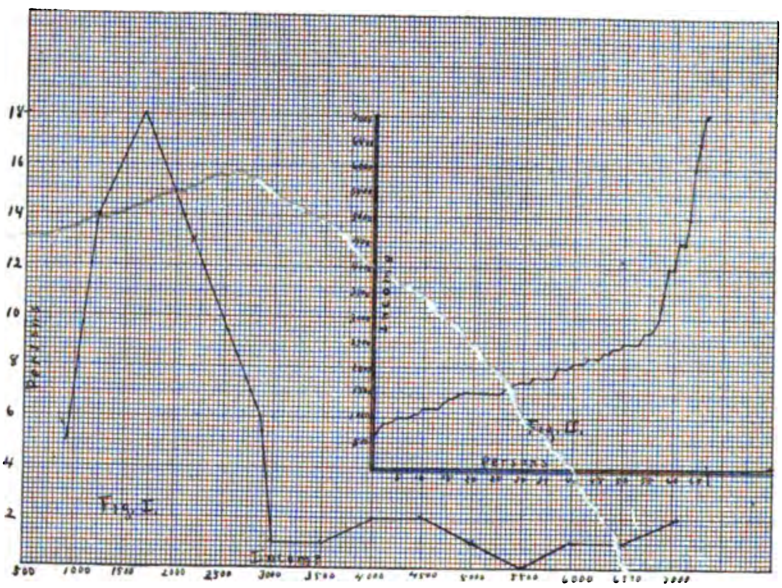
THE class of '99, Dartmouth College, has one hundred living members in the following occupations: Business, 25; teaching, 23; medicine, 14; law, 13; engineering, 10; journalism, 2; railroading, 2; farming 2; study, 2; clergyman, 1; chemist, 1; mining, 1; librarian, 1; unclassified, 3.

The class might be called average. Some were poor, and some were able to live comfortably in college, but every one has had to make his own way in his profession. At the decennial reunion last June, and by mail shortly afterwards, reports were received from sixty-seven of the men stating their incomes for the preceding year. The thirty-three from whom no facts were received are probably getting less income than the average of the class, but I do not think they would lower the average greatly.

The results show an income considerably higher than was thought by those whom I have consulted as to the probable income.

Looking at the plots we see that five men get less than $1,000, with an average of $832; fourteen men from $1,000 to $1,500, with an average of $1,209; eighteen from $1,500 to $2,000, with an average of $1,689; thirteen

from $2,000 to $2,500, with an average of $2,178.60; six from $2,500 to $3,000, with an average of $2,616; and one or two in each of the next five hundred dollar groups, to one man who got $7,000. The average income for the class was $2,097.25. The average for the fifty-six who got less than $3,000, *i. e.*, 83 per cent. of those who reported, is $1,705.70. Forty men are below the average of the sixty-seven who reported.



In Fig. 1 the number of persons in each five-hundred-dollar group is shown at the point of average income. In Fig. 2 we have the income of each individual.

The commercial value of a college education is often discussed, and it would be a matter of interest if a considerable number of statistics of this sort could be secured.

Herbert Adolphus Miller

Olivet College

SOCIETIES AND ACADEMIES

THE MICROSCOPICAL SOCIETY OF ILLINOIS

The regular October meeting of the State Microscopical Society of Illinois was held on October 8, after the usual summer intermission, at the club room, Wesslick's Restaurant, Chicago.

Francis T. Harmon gave an address on "Photomicrography," and exhibited the specially constructed apparatus he used in taking the exquisite photographs which have given him a wide celebrity. A number of these were shown, both in ordinary finish and in natural-color photographs.

At the November meeting in the same place President Marshall D. Ewell described his lately constructed instrument, the micro-colorimeter, for comparing and testing exact and minute differences of color and tint.

Harold D. Skelton exhibited and described the new Bausch and Lomb balopticon for projection, and its capabilities were tested in the projection on the screen of a number of lantern slides, opaque pictures and diagrams, and a variety of microscopic slides or objects shown by various members present.

Dr. S. V. Clevenger read a paper on "Comets and Star-dust," with illustrations by the balopticon.

At the December meeting, held Friday, December 10, Wm. F. Herzberg gave an address on "Crystallography," and the methods of mounting and study of crystals. Most of the evening was spent in study under the microscope of the objects exhibited by the members present.

It was resolved to give another soirée similar to the very successful one of last year, and a committee of arrangements was appointed.

Albert McCalla,
Secretary

SCIENCE

FRIDAY, FEBRUARY 11, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE AMERICAN SOCIETY OF NATURALISTS

CHANCE OR PURPOSE IN THE ORIGIN AND EVOLUTION OF ADAPTATION[1]

THE naturalist lives surrounded by fellow men, whose ideas concerning the origin of living things are still totally at variance with his own. To them creation is a historical drama, and with the act of creation its *purpose* was fulfilled. The naturalist lives surrounded by fellow animals, that show on the whole no change except the chance fluctuations of the seasons or of the years. They give to ordinary observation every evidence of permanency, but no evidence of evolution, and only the highly specialized student reports at times the appearance of new forms.

It is surprising, with these deadening influences always present, that we should sometimes fail to fully realize that evolution is a process now taking place in the same way that it has taken place in the past; that it is a process that we can study directly; something that possibly we can control and direct, and upon our knowledge of which the destiny of the human race may depend.

Convinced that evolution has taken place, admitting that it is still going on, nevertheless the position of the naturalist in regard to the causes of evolution is far from satisfactory and most unsatisfactory concerning the *origin and evolution of adaptation.*

The evidence that evolution has taken place we owe primarily to the paleontologist, but it is historical evidence, at best,

[1] Presidential address at the dinner of the American Society of Naturalists in Boston, December 29, 1909.

and history, as Voltaire said, is "a permanent pleasantry whose sense escapes us."

It is the sense of the process that escapes us. Comparative anatomy has built up a monument of industry, but the foundations lie in the sand. The *assumption* of the theory of evolution makes intelligible the whole of comparative anatomy as no other theory has ever done, and has led many biologists to conclude that it is, therefore, a correct interpretation. I, for one, do not doubt this, but comparative anatomy has nothing serious to say concerning the factors of evolution.

And if we turn to my favorite field of embryology, what is the answer? Von Baer, who enunciated one of the fundamental generalizations of embryology, did not accept the theory of evolution. The recapitulation theory, the most widely accepted statement in regard to the historical side of embryology, has been exaggerated, overdone, and in some quarters thrown into the waste heap of premature speculation. I do not doubt that it aroused a young generation to great enthusiasm for investigation, nor do I doubt that the study of embryology furnishes many clues to the relationships of animals; but I venture to affirm that it has done nothing to advance our knowledge of the *causes* of evolution.

Are we not in rather a hazardous position concerning our belief in the evolution of adaptation? It may be a belief more in accordance with known facts than its great rival, the theory of special creation, but however convinced of its truth, we remain unsatisfied until we can tell how evolution and adaptation have taken place, how they are going on at the present time, and what the future has in store for us.

I hear some one say, "But we know how evolution has taken place; by natural selection." "Perhaps," says his neighbor, "but the Lamarckian principle is the chief agent of adaptation." "Maybe," says a third, "but the environment has had more to do with the origin of species than any other factor, and 'we can prove it.'" "No," says the psychologist, "it is the will to live that brings about evolution, for it is the creative principle of evolution—l'élan de la vie." And the pragmatic philosopher, at the head of the table, adds, "You are all right, my children, evolution has taken place in whatever way you find it advantageous to think of the process."

Comment seems superfluous, but in the flux of opinion concerning the process of evolution there are two general points of view of fundamental moment for every thinking man.

To the majority of evolutionists accepting the theory of natural selection, evolution is the result of accidental variation; it is haphazard or due to chance. By taking this ground the selectionist feels that he stands on the evidence of facts, for "chance" variations he holds can be demonstrated to occur, and secondly that he escapes the onus of explaining how the adaptive variations arise, for he believes that there is no relation between the creation of something new and the part it subsequently plays in the welfare of the species.

But to other minds, or temperaments, such a conception of the origin of the living world seems inconceivably crude. To them it seems beyond comprehension that the evolution of a man, for instance, from an amœba, for example, has been due only to accidental or chance happenings. They *feel* that some more direct and intimate relation must exist between the origin of a new part and the use it comes to subserve.

Grant that many false steps have been made, admit that countless individuals

have been born to perish, what has given us the *progressive* chains of beings? Chance, says one extreme view; purposeful response, says the other.

I need not repeat before this body of naturalists that to-day we have dropped entirely the antiquated use of the word chance as something not subject to the laws of mechanics. That conception of chance arose, no doubt, because chance events are those that can not be predicted individually and what he can not predict seems to the confused thinker to disobey the causal law. Out of his ignorance he imagines blind happenings.

We mean by chance, in ordinary speech, two main things. "I chanced to be there," we say, meaning that our being there was not connected with what occurred, not that mysterious forces, instead of two legs, carried us there. The other meaning is that of a large number of possible combinations a particular one happened.

Darwin used chance *variations* as synonymous with fluctuating variations. He clearly understood that a chance variation is one due to some unknown cause or combination of causes.

But it is the other sense of the word chance that is of capital import for the matter we have in hand. In this sense chance means that a variation having appeared, *chanced* to find a suitable environment. In this latter sense only is it desirable to use the word chance in connection with organic evolution. The confusion of this meaning with the other one which applies to the *origin* of a variation has led to a regrettable obscurity in the minds of some evolutionists.

Darwin's famous book is entitled "The Origin of *Species*" but his theory of natural selection explains the *adaptations* of living things. Darwin was in a large measure concerned with demonstrating that species, in the Linnæan sense of species, arose by evolution, not by special creation. He has himself said:

> Hence if I have erred in giving to natural selection great power, which I am very far from admitting or in having exaggerated its power, which is in itself probable, I have at least, as I hope, done good service in aiding to overthrow the dogma of separate creations.

But to-day, accepting evolution, we are concerned as to whether the theory of natural selection explains the *origin of species,* or whether it explains the *adaptations* of animals and plants. These two questions have often been merged into one, yet it is notorious that, by systematists, specific distinctions rest in many cases on differences that have no adaptive significance whatever.

If, then, the systematist's definition of species is what we mean when we speak of species, and this definition does not concern adaptive characters (or only incidentally) clearly it is futile to attempt to explain the *origin of species* by the theory of natural selection.

Curiously enough, we do, I think, when speaking of *adaptation,* attach one meaning to the word species and another meaning when speaking of *evolution.* In the latter case we often fall back upon the definitions of the systematist. When we speak of the evolution of adaptations, through natural selection, however, we are thinking of organisms as groups that are structurally and functionally adapted in different ways to the environment in which they live, and differ from all other groups in these relations to the environment. These adaptive characters do not, however, in most cases lend themselves to sharp definition for purposes of identification and are shunned, therefore, by the systematist. If I am right on this point, the characters of systematic zoology are, at most, only parts of adaptive structures

and are generally only by-products of the process of evolution—characters that belong for the most part to the dump-heap of evolutionary advance; and whilst they, like all characters, call for explanation, the student of adaptation of the living world (regarding adaptation as the fundamental problem of evolution) will pass them over as of trivial importance for his ends.[2]

Our problem, then, concerns the adaptations of species, and from this time forward when I speak of the origin of species I mean the origin of the adaptive characters of species.

Modern thought has rejected the theological view of the miraculous origin of animals and plants, but philosophy still discusses the question whether there is something purposeful residing in matter or controlling matter that has brought about the adjustments between the animal and its environment, while science turns rather to the question whether adaptation is not the result of a reaction between the organism and the outer world; and if so, in what sense we are justified in applying chance to such a process. Let us examine briefly the philosophical and scientific points of view.

We have sufficient evidence to show that animals and plants *sometimes* respond directly in an adaptive way to changes in their environment; to such agents as food, or light, heat and cold, moisture and dryness.

When we recall that since the first beginning of life on the earth, plants and animals have been subjected to these kinds of physical influences, and the forms that have persisted are those that have reacted adaptively, it is not surprising that they should respond at times, if not always, adaptively even under new conditions. The fact that some directly adaptive responses occasionally occur can not, however, be used as an argument that all adaptive responses have so arisen.

The adaptive response to poisons, or to foreign bodies of any kind introduced into the animal, is one of the most remarkable phenomena of adaptation. In the great majority of cases the response is specific for a particular poison, and the poison, such as abrin, may be one with which the animal can have had no previous experience. A leading pathologist has not hesitated to state in this connection:

> If our studies in infection and immunity have any meaning, they teach us, that . . . adaptation is primarily an active process or at least inevitable and in no sense subject to chance. It is not the mere fortuitous, passive modification of living matter in a favorable direction, but a process whereby that living matter is able to a greater or less extent to change and suit itself to its environment.

The adaptive character of these responses loses some of its mystery, although none of its interest, if, as has been suggested, the poison acts by becoming first incorporated in the living tissue and the living tissue in consequence sets free certain products of the reaction or possibly products of its own break-down whose presence in the blood serves to lock up the poisonous substances. It has been suggested that this process is similar in many ways to the process of assimilation of food by the organism. If this point of view recommends itself, it shows how the organism is a machine already prepared to do this sort of work, and the cases that fill us with astonishment may turn out to be but variations of a process essential to all metabolism.

[2] This statement is not, of course, to be understood to underrate the great value of systematic work; I wish only to emphasize that the evolution of adaptive characters, rather than of systematic characters, is the question of absorbing interest to the naturalist.

More familiar is that class of adjustments by means of which, through use of a part, its functional activity becomes more effective; the muscle grows strong, the skin thickens, the iris contracts and even the bones bear witness to stresses and strains. Here also we are beginning to see that these adjustments may be nothing more than extensions of the normal processes of growth—function breeds function, because the very act of functioning is itself a step towards further change in the same direction.

One of the most remarkable adaptations is the development of a whole embryo out of half of an egg. But here, too, we have come to see that the result is not due to any special and sudden development of a new and wonderful power, but that the regulative process is a simple expression of the same processes that are at work in normal development. The marvel is no more, no less, than that of development itself.

These four great groups include many of the most important kinds of adaptive responses shown by organisms. We can not afford, I think, to underestimate their importance. But observe! They all concern the individual; they tell us nothing in regard to the next generation. Yet even here there has been slowly accumulating in recent years evidence to show that *some* of the external agents that affect the soma or body of the individual may affect the eggs in the ovary of that individual in exactly the same way.

This evidence fails, however, to show that it is the adaptive responses only that take place alike in germ and soma. The evidence indicates at most that certain kinds of external factors may affect soma and germ in the same way, and that these effects apply equally to beneficial, indifferent and baleful results. There is no satisfactory evidence in favor of the view that specific structures produced first in the soma can be transmitted from soma to germ; and least of all is there any evidence that the eggs or the sperms are affected by the psychic experiences of the body. Yet it is this latter idea to which the Lamarckian school has so often appealed. In recent times the Lamarckian has played a losing game. He has been driven from pillar to post and failed to make good many of his claims, which, if true, should furnish the fairest opportunity for demonstration that the whole field of adaptation has to offer.

We find in this connection a significant fact. Nature has not hesitated to insert an unspecialized egg and sperm between every link in the evolutionary series. She seems more concerned in transmitting a material sensitive to external responses than the effects of previous responses themselves.

We are now in a position to attack what is generally conceded to be the central problem of adaptation. It is held that the crucial test of any theory of adaptation is found in those cases where special contrivances exist, that could not have arisen through action and reaction in a causal sense: for example, in many insects the male and female organs of copulation show close adjustments to each other; those of the male having parts that fit precisely corresponding parts of the female. These fittings vary from species to species, and a change in the male finds a corresponding change in the female of the same species. I shall call these lock and key adaptations—structures and functions complete at birth of the organism. It is a consideration of these adaptations that has separated the naturalists as a class from the physiologists, and has drawn the nat-

uralists and philosophers together—for better, for worse.

Many other illustrations will occur to every naturalist: for instance, the instinct of the caterpillar to spin a coccoon that serves as a protection not so much for itself as for the future pupa, the instinct of the spider to make a web to catch a prospective fly, or of a bird to build its nest for eggs not yet in sight; the occurrence of offensive odors or poisons, or of organs that act as a passive defense for the animal as the spines of the hedgehog or of the sea-urchin, or the colors of animals that may at times serve to protect them. Zoologists have, I think, often let their imagination run riot concerning some of these adaptations, but there remains enough that is probable to satisfy the most sceptical.

I have said that we can not afford to underestimate the *directly adaptive* responses shown by the body, and I have intimated that these are only elaborations of already existing functions. Let me add that the naturalist has equally felt that he can not afford to neglect the lock and key adaptations. The alliance between philosophy and biology is due to the fact that these contrivances are not the result of primary, or directly causal relations, but are secondary relations, which appear to be removed from the province of physical problems in the sense that they are supposed *not* to be the result of causal interaction. It is in this aspect of the subject that chance and purpose bloom forth in all of their significance and danger. It is here, therefore, that it is our duty as scientists to make careful inquiry into what causes the lock to vary and what the key and to discover, if possible, whether there exists any mechanism to insure that they shall continue to vary along the same lines.

Perhaps the following somewhat shopworn case may further illustrate my meaning.

The long coiled proboscis of sphinx moths permits them to reach the juices at the bottom of flowers with a tubular corolla. The proboscis is fully formed when the moth emerges from the pupa and its use has no influence in increasing its length. The proboscis is to the corolla what the key is to the lock and yet the lock can have no causal, *i. e.*, direct influence in shaping the key.

If we exclude the Lamarckian explanation, we find many relations of this sort. The speed of the hare bears no causal relation to that of the fox. We can not think of the fox in the sense of a physical environment acting on the germ cells of hares; yet without the fox the hare would, we feel confident, never have developed the long hind legs. In brief, the zoologist has come to look upon contrivances of this kind as the very essence of adaptation. He finds himself in consequence facing two alternatives, neither of which is he anxious to accept. On the one side are the champions of chance; on the other, the apostles of purpose. The issue may *seem* to have reduced itself to these alternatives.

I beg your attention for a little while to consider the import of this decision, and I will take Bergson's view in his "L'Évolution Créatrice" as the clearest and most profound expression of the hypothesis that adaptation of the living world is the outcome of a creative force that shapes matter for an immediate purpose, though not according to a preconceived or predetermined purpose. Many philosophers have assumed a creative principle of some kind that directs the organic world, but have generally taken an anthropomorphic conception of the process. Bergson, on the other hand, conceives of creation without

a creator—he formulates a creative principle that does not postulate the doctrine of finality. His élan vital adjusts itself to each new need that arises; does not work on a preconceived or foreordained plan, but adapts itself to the matter and to the situation in the same way in which an inventor will take the materials at hand and shape them to his purpose with the tools at his command.

It seems to me—I may be wrong—that this theory of the origin of adaptation will not find wide acceptance with the militant evolutionist of to-day; and I shall attempt to formulate the reasons why it seems to me he is likely to refuse to accept so attractive a view, even when so persuasively presented.

In the first place, the theory tells us everything and tells us nothing. It solves the problem by begging the question. An internal principle of which we know nothing steps in like the fairy in the story and does all that is required.

In the second place, Bergson's theory attempts to solve one of the ultimate problems of biology by *a priori* argument—a method from which science has suffered much and has come to look upon askance. Our experience in studying living things teaches us that only by patient labor extending over many years are we likely to gain a little insight into even the simplest modes of action. We feel that there is no royal road to the solution of such complex questions.

And lastly, Bergson's theory, like many of its kind, directs its attention to that side of the problem that is entirely beyond our present ken, namely, the intimate nature of the reaction itself. It lays in consequence on the problem an emphasis that is foreign to our scientific discipline. It may be good philosophy or excellent metaphysics, but it distracts the scientist from his more modest aspirations. It is as though the physicist directed his attention to an explanation of why hydrogen combining with oxygen should give the qualities that we recognize in water; or why the particle of sodium chloride should give a crystal having the form of a cube. If the chemist or physicist disclaims any such ambition, how much more must the biologist disclaim any knowledge—nay, the possibility of any such knowledge, at present, of the behavior of highly complicated organic matter.

If from the point of view of the working evolutionist I have ventured to criticize Bergson's "L'Évolution Créatrice," I beg that you will not understand me to say that I am unappreciative of its value in other directions. On the contrary, as a contribution to speculative metaphysics, it has unusual fascination; as a contribution to that higher form of literary art that we call philosophy, it is an admitted masterpiece. But the day is fast disappearing when the scientific study of evolution can be exploited for literary purposes—except for literary purposes. Paper evolution has fallen into disrepute.

If then we fail to find intellectual satisfaction in the idea that adaptations have arisen as a conscious response of the animal, what alternative does the *theory of chance* offer?

The only legitimate sense in which chance can be applied is, as I have said, that the variations happened, *i. e.*, chanced, to find an environment suited to them. In this sense we speak of evolution as a chance result. Nevertheless, I think most of us feel, as I have said, that there must be some closer bond than chance that insures the *continuance* in a given direction of variations once begun. Even Weismann, a typical neo-Darwinian, admitted in his interesting essay on Germinal Selec-

tion, that unless we can find such a relation, the whole fabric of natural selection falls to the ground; and, as is well known, he attempted to supply this deficiency in his competition of the biophors in the germ-cells. His attempt has failed, on the whole, to bring conviction that the result has been reached in this way, but his statement, in regard to the weakness of the appeal to chance, has, I believe, struck a responsive cord.

It seems to me that we get a suggestion of how continuous adjustment is more likely to occur if we refer variations not to internal conflicts of the biophors, but to the action of external factors on the germ plasm, and *assume* that germinal material that shows itself susceptible of change in an environment is more likely to show further variations in the same direction in that environment.

On some such view we can better understand how evolution along adaptive lines is more likely to give further variations in the same direction, and there is not a little evidence in favor of this view in the history of domesticated animals and plants. After the first step, which was undirected, *i. e.*, not purposeful, the subsequent events are rendered more probable; for the dice are loaded. Evolution along adaptive lines would be a consequence of the very processes that variation has initiated.

The same idea shows how incipient stages of organs may progress until they become of positive advantage to the race and may ultimately carry it along a progressive line of evolution; or should the variation be baleful, lead in its ultimate development to the destruction of the species.

Turning now to another aspect of the subject, I think that our ideas concerning chance and purpose have been largely influenced by those creative processes in which man himself *seems* to have played a leading rôle. I refer to the artificial production of our domesticated animals and cultivated plants.

We owe to Darwin chiefly a comparison between certain features in the development of adaptation under domestication and the development of adaptation in nature.

Domesticated hens lay more eggs than *Gallus bakkiva*. Cows give more milk than buffaloes. Apples in an orchard are larger than in the forest. Potatoes are bigger in a garden than in the wilds of Chili. Why? In part, no doubt, because better conditions of soil or of feeding keep up the product to its maximum, but no one will claim for a moment that the only difference is in the better conditions of food. We realize that the results have not and could not have been obtained from the wild forms at once, but only through a long process of artificial selection by which the domesticated animals have become *adapted* to man's needs.

Admitting this, as one must, what is its bearing on our problem? It is admitted that artificial selection has created nothing new, it has supplied only an opportunity for what already appeared, as new, to remain in existence, but, by picking out the new variation and isolating it under conditions where it can live, *purpose* enters in as a factor, for selection had an end in view.

By preserving the variation the possibility of further variation in the same direction is insured.

We see clearly enough the rôle that chance and purpose play in these processes. The first variation is the result of the environment acting on the organism; it happened, "chanced," to appear at a time when a man was there to give it an opportunity to live. And about its pur-

pose? It could only be said to have purposely *arisen* because it was conscious of a man in its vicinity that would protect it, which is sheer nonsense to most of us. This would mean from Bergson's point of view that cows began to give more milk under domestication because the "élan vital" of the cow made a sacrificial offering to man on the altar of their common interests; that hens laid more eggs on the same altar and that the fancy races of fat pigs have arisen from disinterested or unsophisticated motives so far as the creative principle in the pig is concerned.

But after a new variation had arisen we may speak of purpose as a directive agent in the formation of domesticated races, in the sense that man supplied the purpose when he selected the new variation. The next step was again due to a further action of the environment, but the direction of that action was to some extent prejudiced by what had already taken place. Usefulness to man was the direction in which new variations were made more probable.

Let us see how by adjusting this scheme to nature our alternative of chance or purpose fares. As before, we assume a first variation arises through external factors. If it finds a suitable place it survives. Here there is no purpose unless in the far-fetched sense that finding the external world suited to itself "is a purpose"; rather is the result due to chance. But there is another side to the question from the Darwinian point of view; for, while it is admitted that chance may in some cases have to do with survival as just defined, yet survival is due on the whole more often to *competition;* when the race is to the swift and the battle to the strong. It is for a purpose that an organism crowds out its competitors, for the purpose of survival—not conscious purpose, perhaps, but in a different sense the *result* is purposeful. So I think by a shifting of the angle of vision one might come to look upon survival in nature as purposeful in the same sense in which that term is applied to artificial selection. By this substitution the old and familiar phrase, purpose, might still be applied in a *perverted sense* to the theory of natural selection, and possibly the popular extension of the theory may have been in part due to the easy psychological transition thus afforded.

But does this conception of the evolution of adaptation accord with our experience? Is the battle always to the brave—for the brave is sometimes stupid—or the race to the swift, rather than to the more cunning? Have we here a true picture of the evolution of adaptation?

An individual advantage in one particular need not count much in survival when the life of the individual depends on so many things—advantages in one direction may be accompanied by failures in others, chance cancels chance. Take, for example, the human race, the conditions of which we know perhaps better than those of any other. An individual may be highly gifted in one direction compared with his fellows. He may win a Marathon, or have more intelligence; he may have a better physique, or a more perfect digestion; but he does not therefore necessarily leave more descendants even if his advantages bring material and social rewards. There are no records, so far as I know, to show that we can trace back to only a single pair of superior individuals any preponderating number of individuals of succeeding generations; often the reverse is observed, for the more highly gifted often have fewer offspring. It seems to me that what we know is at variance with the widely accepted interpretation that the individual

through his own advantages replaces by means of his offspring the rest of the population. Rather do we find that the progressive races are those in which the environment causes definite variation in the largest number of advantageous directions. The race advances by the accumulation of these variations. Many individuals of the race contribute towards its maintenance by adding to its advantages, some in one way, some in another. And they do so, not by supplanting their fellows, for each advantage to be gained, but by combining with them. The new variations are the products of the environment. Their perpetuation by grafting on to the race raises the race to a level from which further variations in the same direction are possible. Sexual reproduction comes to have an unexpected meaning, for through it the contributions of the individuals are added to the race. It seems to me that some such interpretation as this is more nearly in accord with our present knowledge of the origin of adaptation. If so, we should expect advance in the human races to take place not by every man's hand being raised against his neighbor, nor by the picking out of a few choice individuals in the way the breeder produces new varieties of corn, horses, pigeons and pigs, but we should expect advance to take place in those parts of the world where there is a good stock to start with, and an environment that calls forth in that stock favorable variations in excess of unfavorable ones.

It seems preposterous to us that so highly organized a machine as the human body could have evolved by undirected variations and chance combinations from a formless mass of living matter. But such a statement of the problem gives a false impression, if, as I have tried to show, each step that the organism has taken guarantees further responses in the same direction. And, since the steps that count are the adaptive ones, the very essence of the process of evolution is such that the organism is carried along adaptive lines. The mechanism of survival (if I may be pardoned the expression) is such that it insures success where it is most called for. To repeat a familiar epigram: In evolution nothing succeeds like success.

In conclusion, I owe you, I fear, an apology for attempting to discuss so serious a theme at this time and occasion, when high living may not be conducive to plain thinking. In the detail of every-day work in which we are plunged we are apt to lose sight of the relative value of the problems at which we work. It seemed to me, therefore, that it might not be inappropriate this evening to focus our attention on the large problem of organic adaptation, which is still, I think, the central problem of the naturalist; and if in attempting an analysis of the present situation I have allowed my imagination too free rein, I submit, in defense, that the human mind has an ineradicable tendency to probe into the unknown, and that the fires of the imagination, kept alive by human curiosity, may also serve a purpose in the progress of human thought, *provided* the imagination is controlled at every advance by an appeal to experience, and is used as a tool and not as an end in itself. But I frankly confess that I feel, as no doubt every one does who tries to keep in touch with modern work, that the time is past when it will be any longer possible to speculate light-heartedly about the possibilities of evolution, for an army of able and acute investigators is carefully weighing by experimental tests the evidence on which all theories of evolution and adaptation must rest. To them belongs the future.

T. H. Morgan
Columbia University

THE MAGNETIC SURVEY OF CHINA

MR. DON C. SOWERS, sent out in November, 1908, by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, to secure magnetic observations in China and Chinese Turkestan, returned to Washington last December.

Besides the leader, the party consisted of Professor C. G. Fuson, of Canton Christian College, a Chinese interpreter and a cook. Leaving Peking January 30, 1909, they went as far as Honanfu by rail; thence traveling by Chinese carts, pack animals, mule chairs, etc., the party proceeded along the great northern trade route of China, passing out of China proper at the end of the Great Wall in northwestern China, thence across the Gobi Desert to Urumtsi, the capital of Chinese Turkestan. Continuing in a southwesterly direction, skirting the Taklamakan Desert, along the south side of the Tien Shan Mountains, the expedition finally reached Kashgar, in the western part of Chinese Turkestan on July 28. Turning here to the southward the Himalaya Mountains were crossed via the five passes of the Karakorum trade route, the highest trade route in the world, arriving at Leh, India, in September, and at the railroad at Rawal Pindi, northern India, October 13.

The overland journey from the terminus of the railroad in China to the place where the railroad was again reached in northern India was over 4,500 miles in length and required eight and one half months to accomplish it. It lay through a little frequented and, until recent years, unexplored portion of the globe. It is a region full of interest for the geographer, historian and scientist.

The party was everywhere shown the utmost courtesy and every possible assistance was rendered by Chinese officials as well as by representatives of foreign governments.

Connection was made at Dehra Dun with the magnetic survey of India, at present in progress under the direction of the British government.

SCIENTIFIC NOTES AND NEWS

SURGEON CHARLES F. STOKES has been nominated to be surgeon-general of the navy, to succeed Surgeon General Presley M. Rixey, who retires.

ON the evening of April 2, at the Waldorf-Astoria, a dinner will be given in honor of Dr. Charles F. Chandler, head of the department of chemistry of Columbia University, whose resignation after forty-seven years of service will go into effect next June.

THE Geological Society of London will this year award its medals and funds as follows: the Wollaston medal, as already announced, to Professor W. B. Scott; the Murchison medal, to Professor A. P. Coleman; the Lyell medal, to Dr. A. Vaughan; the Wollaston fund, to Mr. E. B. Bailey; the Murchison fund, to Mr. J. W. Stather; the Lyell fund, to Mr. F. R. Cowper Reed and Dr. R. Broom.

THE council of the Royal Geographical Society has decided to award a special gold medal to Commander Peary for his journey to the North Pole, and for having undertaken such scientific investigations as his opportunities permitted; and a silver replica to Captain Bartlett for attaining eighty-eight degrees north latitude. It is expected that Commander Peary will lecture before the society on May 4. Later in the month he will lecture before the Berlin Geographical Society, which will confer on him its gold medal.

PROFESSOR W. BATESON, who vacated a fellowship at St. John's College, Cambridge, on resigning the professorship of biology in the university, has been elected to an honorary fellowship.

MR. JOHN D. ROCKEFELLER, having learned of the distinguished services to medical science which have been and are being rendered by the researches of Professor Paul Ehrlich, of Frankfurt, Germany, has presented to the board of directors of the Rockefeller Institute for Medical Research the sum of ten thousand dollars to be placed at the disposal of Professor Ehrlich for furthering his investigations into the chemical therapy of the protozoon diseases.

THE New York *Evening Post* states that Professors H. N. Morse, H. C. Jones and S. F. Acree, of Johns Hopkins, have received their sixth annual grant from the Carnegie Institution of Washington for the prosecution of

special researches in chemistry. Professor Morse and his assistant, Dr. W. W. Holland, are engaged on the subject of osmotic pressure, especially at higher temperatures. Professor Jones and Dr. W. W. Strong are studying quantitatively the absorption spectra of various solutions. Professor Acree and Dr. B. B. Turner will continue their investigations on tautomerism and the theory of catalysis.

Dr. T. C. Chamberlin, professor of geology in the University of Chicago, has been elected president of the Geological Society of Chicago.

The Chanute Medal, which is each year awarded by the Western Society of Engineers for the best paper presented to the society in the field of civil engineering during the preceding year, has been given to Professor Arthur N. Talbot, of the University of Illinois. Professor Talbot's paper is entitled "Tests of Cast-Iron and Reinforced Concrete Culvert Pipe." The foundation for the medal given by the Western Society of Engineers was established by Dr. Octave Chanute. The arrangement provides for three medals, one for work in mechanical engineering, one in civil engineering and one in electrical engineering.

The council of the Royal Astronomical Society has awarded the gold medal of the society to Professor F. Küstner, director of the University Observatory of Bonn.

Dr. Chas Morrey, head of the department of bacteriology in the Ohio State University, has been given leave of absence for the next academic year.

Mr. W. H. Pew, assistant professor of animal husbandry in the Iowa State College, has declined the directorship of the New Hampshire Agricultural Experiment Station.

A committee has been formed in England, the membership of which includes the Italian ambassador, the Marquis of San Guiliano, Sir Thomas Clifford Allbutt, regius professor of physics at Cambridge, and a number of prominent scientific men and physicians, to promote the investigation and study of pellagra.

Sir Ernest Shackleton has denied the report that he is to lead another expedition to the Antarctic.

Reuter's Agency learns that the first member of the British Antarctic Expedition under Captain Scott, Mr. Cecil H. Meares, has left England. He is going to Siberia to obtain dogs and ponies for use in the expedition. Except that he is to make a brief stay at Moscow, Mr. Meares travels direct to Vladivostock. Thence he will proceed north to the Amur and by means of sledges will press further north to Yakut, a great sable center in Yakutsk, where animals will probably be procurable. Later he may leave to go to Okhotsk and on to the Verkhoiansk Mountains, a region which is described as being almost, if not quite, the coldest in the world. Mr. Meares intends to get most of his dogs, particularly the main team leaders, in Siberia. This part of the work is likely to occupy between three and four months. Mr. Meares will then begin the collection of ponies in the country round Harbin, and, with his animals, will join the main body of the expedition on board the *Terra Nova* in New Zealand in December.

Professor Joseph Jastrow, of the department of psychology of the University of Wisconsin, has accepted the general editorship of a new series of psychological manuals for the general reader, to be known as the "Conduct and Mind Series." His own contribution to the series will be a work on "Character and Temperament." The introduction to an English edition of Professor Gross's "Criminal Psychology," about to be issued as the first number of a series of translations of important foreign works on the subject by the American Institute of Criminology, will be written by Dr. Jastrow. He leaves the university the second week of February to spend the second half year as lecturer at Columbia University.

Dr. Arthur T. Hadley, president of Yale University, will deliver the oration on golden jubilee day, May 17, next, when the fiftieth anniversary of the foundation of the College of California, the precursor of the University of California, will be celebrated.

Professor John Dewey, of Columbia University, gave, at the Johns Hopkins University, from January 31 to February 5, a course

of six lectures on "Aspects of the Pragmatic Movement of Modern Philosophy."

Professor R. A. Daly, of the Massachusetts Institute of Technology, gave five lectures to advanced students in the Geological Department of the University of Wisconsin in January on the subject of Igneous Rocks.

Professor Carl Runge, of Göttingen, Kaiser Wilhelm professor at Columbia University during the present year, is now giving lectures at several American universities. At the University of Michigan he has given the following course:

February 4—"Methods of Graphical Calculation."

February 5—"The Graphical Representation of Functions" (first lecture).

February 7—"The Graphical Representation of Functions" (second lecture).

February 8—"Graphical Integration and Differentiation."

February 10—"Differential Equations Treated Graphically."

A statue of the late Morris K. Jesup, for many years president of the American Museum of Natural History, was unveiled in the foyer of the museum on February 9. The statue, which is of Carrara marble and represents Mr. Jesup seated, is the work of Mr. William Couper. Addresses at the unveiling were made by Dr. Henry Fairfield Osborn, who has succeeded Mr. Jesup as president of the museum, and Mr. Joseph H. Choate, one of the founders of the museum.

The three great meteorites, brought by Commander Peary from the Arctic regions and for some time exhibited in the American Museum of Natural History, have been purchased and given to the museum by Mrs. Morris K. Jesup.

The firm of Dr. F. Krantz, of the Rheinisches Mineralien—Contor, Bonn, Germany, has requested Dr. M. E. Wadsworth, dean of the School of Mines of the University of Pittsburgh, to assist the firm in preparing a collection of crystal models to accompany Dr. Wadsworth's recently published laboratory "Manual of Crystallography."

A series of lantern slides especially designed for use by teachers of physical geography has been prepared by Professor D. W. Johnson, of Harvard University. The slides are photographic and contour representations of the same land form on the same slide, the map being so oriented that its bottom is the foreground of the photograph. Many of the views reproduced are from Professor Johnson's own negatives; the rest are from photographs in the Garden Collection of Photographs at Harvard University.

The Liverpool Geological Society, as we learn from *Nature,* celebrated the jubilee of its first meeting on January 10. The society entertained at dinner the Lord Mayor and representatives of the university, of kindred societies in the city and of the Yorkshire Geological Society and the North Staffordshire Field Club. The toast of the university elicited expressions of regret at the absence of a chair of geology in the university. The first meeting of the society having been held on January 11, 1860, an open meeting was held on January 11, and was largely attended. Mr. W. Hewitt, the president, was in the chair, and the minutes of the first meeting having been read, he remarked that that meeting was held in a room in the house of Mr. G. H. Morton, the first honorary secretary of the society. He also read a letter from Mr. H. Duckworth, the first president, congratulating the society and regretting that his age prevented his being present. Professor J. W. Judd, C.B., F.R.S., an honorary member of the society, then delivered an address on "The Triumph of Evolution: a Retrospect of Fifty Years," remarking that the foundation of the society was nearly coincident with the appearance of Darwin's "Origin of Species."

Twenty lectures by non-resident lecturers have been arranged by the mechanical engineering department of Columbia University. Charles B. Going, managing editor of the *Engineering Magazine,* will give the first six on February 10, 12, 17, 19, 24 and 26, his subject being "The Province of Works Management." Charles U. Carpenter, president of the Herring-Hall-Marvin Safe Co., will lecture on March 5, 10, 12 and 17, on "The Functions of Organization, its Purposes,

Scope and Object." H. L. Gantt, consulting engineer, will lecture on March 31 and April 2 on "The Compensation of Workmen." Walter M. McFarland, vice-president of the Westinghouse Electric and Manufacturing Co., will lecture on April 7 on "The Importance of the Commercial Elements in Engineering Achievement." Harrington Emerson, consulting engineer, will lecture on "Works Management," on April 14, 16 and 21. Richard T. Lingley, treasurer of the American Real Estate Co., will lecture on "Bookkeeping," on April 30, May 5 and 7. E. J. Prindle will lecture on May 14 on "Patents as a Factor in Manufacturing Operations."

THE medical department of the University of Michigan offers the following list of lectures as extramural university extension work. The same lectures are also delivered during the course of the year, during the summer school to university students and town's people of Ann Arbor, and are delivered anywhere in the state of Michigan under the conditions mentioned in the medical calendar.

"The Evolution of the Superman: The Fight against Tuberculosis," by Dean V. C. Vaughan.

"Medicines: Their Use and Abuse," Professor Edmunds.

"Psychotherapy," Professor Camp.

"The Prevention of Insanity," by Professor Barrett.

"The Rôle of Insects in the Transmission of Disease," by Professor Novy.

"The Prevention of Tuberculosis; the Venereal Diseases and their Extermination," by Professor Warthin.

"Development as an Aid in the Interpretation of Structure," by Professor Huber.

"The Care of the Eyes in Children," by Professor Parker.

"The Problem of Pure Milk; Children's Diseases," by Professor Cowie.

"The Prevention of Premature Old Age," by Professor Hewlett.

"The Cancer Problem," by Professor Peterson.

IN accordance with a request of the Chilean government, transmitted through the customary diplomatic channels, the commissioner of education calls attention to the announcement of an Exposition of Fine Arts to be opened at Santiago, Chile, on September 18, 1910, as a feature of the Chilean centennial. This exposition will be held in the recently erected Palace of Fine Arts which will form a permanent memorial of the occasion. Works of art intended for this exposition must be forwarded before the first of May of the present year. Full particulars with respect to the plans for the exposition may be obtained by addressing the general secretary, Mr. Ruchon Brunet, Santiago, Chile.

THE London correspondent of the *Journal* of the American Medical Association writes that the prohibitive price of radium has led to the establishment of a novel institution—a radium bank where the precious metal may be stored and rented to physicians, scientists and others who wish to use it but can not afford to pay $80 a milligram, its present market price. The ultimate locality of the bank is to be in the neighborhood of Cavendish Square, in the heart of the district in which London consultants live, but for the present temporary offices have been opened at Moorgate street in the heart of the commercial and banking district of the city. For an average operation 50 milligrams of radium are required, costing $4,000 and, therefore, it is only at one or two of the London hospitals that radium can be used to any extent. A number of business men have combined to form the bank which will "let" 100 milligrams at $200 for one day's use and for each subsequent day at one half per cent. on the value of the amount issued. Securities will have to be given. The bank purposes to stock radium to the value of $250,000. The difficulty is in getting a supply of radium. The main source has been the pitch-blende from Joachimsthal, Bohemia, which yields one part in 3,000,000. A new supply has been discovered in the bed of a stream near Guarda in Portugal. In England two Cornish mines have yielded a little but the whole available supply is limited owing to the enormous expense of extraction. Although radium exists in air, sea water and almost everywhere, there is hardly an ounce of the pure metal in the world. The bank will be organized very much

after a model of a similar institution in Paris, through which most of the radium used in England has hitherto come.

The Institute of Chemistry is issuing, as we learn from the London *Times*, the third edition of the "List of Official Chemical Appointments," prepared by its secretary and registrar, Mr. Richard B. Pilcher. The work is intended primarily for the use of professional chemists and those who contemplate making chemistry their profession, but it should prove useful also to those who are interested in the applications of chemistry to the purposes of the state and in the promotion of higher education in the science. It is arranged in three divisions. The first gives official appointments in Great Britain and Ireland under the various departments of state, local authorities and public institutions and teaching appointments in the universities, colleges, technological institutions, medical, agricultural and veterinary colleges and public and secondary schools. The second contains similar information for India, Australia, New Zealand, British South Africa and British colonies and protectorates, with Egypt and the Sudan; while the third gives a concise account of societies and institutions devoted to the advancement of chemical science and of professional chemical interests.

The College of Mechanical and Electrical Engineering of the University of North Dakota has secured additional quarters 170×40 feet in which will be located the steam, gas and electrical engineering laboratories and the iron foundry. The new engine room is to have as a part of its equipment a 70 horse power automatic cut-off high speed steam engine, two 25 kilowatt electrical generators, a 12 horse power gasoline engine, and a 55 horse power producer gas engine. The new boiler-room will have three 70 horse power fire tubular boilers. These last are of the same make and each will be provided with different type of furnace and different grates. One will be equipped with an automatic mechanical stoker, another with a special combustion chamber, while the third will have the furnace usually installed with this type of boiler. The college will undertake to determine the relative efficiency of the different types of furnaces in burning any given fuel and to determine also the relative steaming qualities of different fuels when burned in the three distinct types of furnaces. In the boiler room a 50 horse power suction down-draft gas producer designed to handle lignite and soft or bituminous coals. With certain modifications it can be converted into an up-draft gas producer capable of handling anthracite and coke. In selecting the power equipment it is the idea of Dean Crouch to install such apparatus and machinery as will enable the college to investigate the best ways and means of utilizing North Dakota lignite (in which the state abounds) and of converting the same into power. That the results obtained may have a practical value, the units selected are of sufficient size to give fair indications of what may be expected from commercial plants. The experimental engineering laboratories are supplied with various types of electrical generators, motors, transformers, etc., and are equipped for testing all kinds of steam, gas, hydraulic and electrical machinery. The iron foundry is being equipped also with a cupola with a melting capacity of two tons an hour.

The following data have been compiled by Messrs. Waldemar Lindgren and H. D. McCaskey as a preliminary review of the gold industry in the United States in 1909. Gold mining progressed, on the whole, very satisfactorily in 1909. The year was marked by increasing recovery from the depressed conditions of the two years immediately preceding and by general advance in the development of proved mines and districts. Although these improvements resulted in a generally increased production of the base metals, and as a consequence augmented the gold output, they did not seriously detract from those gold-mining operations which had benefited during the late panic by the closing of numerous copper, lead and zinc mines and the consequent release of skilled labor for gold mining. From the preliminary figures of the Director of the Mint, which have just been published, it is estimated

that the output of gold for 1909 reached the unprecedented total of $99,232,200, an estimated increase of $4,672,200 over the production for 1908. In spite of serious drawbacks, first in one mining camp, then in another, the production of gold has increased more than $4,000,000 in each of the last two years, and the outlook indicates, unless present abnormal conditions in the Black Hills should continue or curtailment be shown elsewhere, a production of over $100,000,000 in 1910. In general, gold production has increased mainly from placers and the mining of siliceous ores, and to a smaller degree from copper ores, from which gold is a by-product. According to estimates from the Bureau of Statistics, the United States imported in 1909 gold valued at $13,510,513 in foreign ore, $26,233,368 in foreign bullion and $6,059,313 in foreign coin, and exported gold valued at $498,822 in domestic ore, $43,021,545 in domestic bullion, $86,803,265 in United States coin and $2,717,725 in foreign coin, the excess of exports over imports thus being $87,238,323. In 1908 there was an excess of exports over imports valued at $30,939,163. The imports in 1909 were made up chiefly of ore and bullion from Mexico and to a smaller degree from Canada and South America. The exports consisted largely of coin and went chiefly to South America, though large amounts of gold were sent to Japan, the United Kingdom and France.

A REPORT on the annual exports of farm products from the United States from 1851 to 1908 from the Bureau of Statistics, U. S. Department of Agriculture, gives averages by five-year periods, so that it is possible to perceive the general drift of the trade. The chief agricultural products exported in the past half century have been (1) cotton, (2) grain and grain products and (3) packing-house products. In 1851–5, cotton made nearly two thirds of the value of all agricultural exports, but in 1901–5 between one third and one half only, although the average quantity exported increased from 1,026 million pounds in 1851–5 to 3,577 million pounds in 1901–5, while in 1907, the highest year, 4,518 million pounds were sent out. In the period 1861–5 the quantity of cotton exports was only about 5 per cent. of that for 1856–60. Increases occurred afterward, however, until in 1876–80 the average quantity exported was somewhat greater than in the period just prior to the Civil War. In quantity exported per capita, the five-year period 1856–60 was highest; there were then exported 44.8 pounds of cotton per capita. The nearest approach to this was 44.5 pounds per capita in 1901–5. Cotton-seed products, such as cotton-seed oil, oil cake and oil-cake meal have assumed considerable importance in the export trade of the United States in recent years, that is, beginning about 1876. The value of cotton-seed products exported averaged during the past several years from 25 million to 30 million dollars a year, the highest being in 1907, about 34 million dollars. Grain and its products come second in order of value. They increased from a yearly average of 25 million dollars in 1851–5 to 194 million dollars in 1901–5, in 1851–5 to 194 million dollars in 1901–5, and in 1908 were 215 million dollars. The chief items are wheat (including wheat flour), corn and oats. Exports of these cereals during 1851–5 were equivalent to about 20 million bushels of grain annually, and fifty years later to about 250 million bushels. The period of largest grain exports was 1896–1900, since which time there has been a decline. The per capita exports of wheat and flour were largest in 1881–5, when they were equivalent to 2.6 bushels per capita; in 1901–5 the average exports per capita were 2 bushels, and since 1905 have been less than 2 bushels. In corn the maximum limit was reached in 1896–1900, when an average of 2.4 bushels per capita was exported. Then came a downward tendency, the exports in the next five-year period being only 1.1 bushels per capita, and in succeeding years falling below 1 bushel. Compared with corn and wheat, exports of oats have been small, the largest average for any five-year period being 38 million bushels a year during

1896-1900, or something more than one fifth the corresponding exports of corn or of wheat, including flour. Exports of packing-house products, a third leading group, have increased much more rapidly in the last half century than cotton or cereals. The average value of packing-house products exported in 1851-5 was 10 million dollars a year, and in 1901-5 it was 183 million dollars, while in 1908 the value was 196 million dollars.

A statement received at the Department of Agriculture from the Forest Service office at Portland, Oregon, shows that the timber sales on national forests in the Pacific northwest is increasing rapidly. This increase is regarded as an index of the revival of business in the lumber industry generally, and shows also the growing use of national forest resources by the public. The contrast between the amount and value of timber sold during the last six months of 1909 and that sold during the corresponding period in 1908 is marked. The figures are for most of the national forests in Oregon and Washington, and show timber sales of over 52 million feet, for nearly $114,000, during the last six months of 1909. This compares with sales of about 17 million feet, for a total of $27,000, during the same period in 1908. The prospects for the coming six months are regarded as promising even better than what has been realized in the period just past. This increasing timber sale opens the way to management of the national forests along the best lines by permitting the removal of over-mature and decadent timber which has practically come to a standstill in point of growth, and allowing replacement of these trees with a fully stocked stand of rapidly growing young trees.

The topographic survey of the Mount Baker quadrangle, in the state of Washington, was completed last fall by members of the United States Geological Survey and the resulting map is being prepared for engraving. The party that made this survey was under the direction of J. E. Blackburn and in the course of the work Mr. Blackburn, with E. H. Jones, T. L. Duncan and C. V. Guerin, climbed Mount Baker, from whose slopes and summit observations were made and mapping was done. The whole mountain is an almost unbroken glacier, only narrow rocky dikes protruding here and there through the vast ice mass. This glacial ice, constantly augmented by snowfall, accumulates in a number of huge gorges, forming glaciers that move down the mountain's sides for several miles before melting. Thus the ends or lower boundaries of the glaciers are about 3,700 feet above sea level, whereas the altitude of the dome of Mount Baker is 10,745 feet. The climb to this summit was made in four hours by the topographic party from its last camp, which was pitched at an elevation of 5,200 feet. Mount Baker was long ago one of the active volcanoes of the Cascade Range, and the steam issuing from the sulphur-lipped vents of its crater today show that its internal fires are not yet entirely dead. The crater is about 1,000 feet below the main dome of the mountain. The summit is a table having an area of about sixty acres. Besides Mount Baker, this quadrangle contains many other majestic mountains. Notable among them is Mount Shuksan which rises abruptly from the canyon of the North Nooksak and terminates in a spire 9,038 feet above the sea. This mountain, although only a few miles distant from Mount Baker, is isolated, and its peculiar structure causes difficulties in making an ascent. Besides these two conspicuous mountains, other peaks along the summit of the Cascade, on the eastern edge of this quadrangle, rise to elevations above 6,000 feet, and, when seen from a distance, the panorama of the Cascade Range presents many views of extreme beauty and rugged grandeur. The mountains in this region are snow-capped throughout the summer, and the snows of the early fall and winter form reservoirs that feed Skagit River, which is probably the largest stream in northwestern Washington. Last December several days of rain and snow followed by chinook winds produced a flood in the Skagit that submerged the plains in its delta region and caused damage amounting to more than a million dollars.

UNIVERSITY AND EDUCATIONAL NEWS

THE Sheffield Scientific School of Yale University has received from Messrs. George G. Mason and William S. Mason $250,000 for a laboratory of mechanical engineering.

FOR the establishment of the George Peabody College for Teachers at Nashville, Tenn., the sum of $1,000,000 has now been given by the board of trustees of the Peabody Fund for the Advancement of Education in the South. This gift was promised some time ago conditional on the granting by the state of Tennessee, the county of Davidson and the city of Nashville of a sum approximating $750,000.

ADDITIONAL gifts amounting to $450,000 to seven institutions were announced after the seventh annual meeting of the General Education Board held in New York City on February 2. These are the appropriations: Williams College, Williamstown, Mass., $100,000 on condition that the college raise an endowment of $1,000,000; Wesleyan University, Middletown, Conn., $100,000 toward $1,000,000; Cornell College, Mount Vernon, Ia., $50,000 toward $200,000; St. Lawrence University, Canton, N. Y., $50,000 toward $200,000; Georgetown College, Georgetown, Ky., $25,000 toward $100,000; the Women's College of Brown University, Providence, R. I., $50,000 toward $200,000; the Salem College for Women, Winston-Salem, N. C., $75,000 toward $300,000.

THE trustees of the bequest of $2,000,000, left by Mrs. Amanda W. Reed, are, as has already been announced, about to establish a college at Portland, Ore., to be known as Reed Institute. Dr. J. H. Tufts, head of the department of philosophy at the University of Chicago, has recently spent some time in Portland on the invitation of the trustees, to advise as to the scope of the institution.

A MEDICAL library of 1,100 volumes has been given to the medical school of the University of Wisconsin by Dr. Byron F. Robinson, a graduate of the university in the class of 1878, now professor of gynecology and abdominal surgery in the Illinois Medical School.

ACCORDING to the *Madras Educational Review*, as quoted in *Nature*, Sir F. D. Lugard, the governor of Hong Kong, has reported to the British government that Mr. H. N. Mody has offered to present the colony with the building necessary to start a university. A committee has been formed, with the governor as chairman, to promote the undertaking. Mr. Mody's original offer was to give a sum of £30,000 for this purpose and a further £6,000 towards the endowment. Plans of the necessary buildings were prepared, and as the director of public works estimated that the cost would not be less than £58,000, Mr. Mody undertook to provide them in accordance with the plans, stipulating, however, that he should use on the buildings the £6,000 originally given for endowment if it should be required.

ALBERT JOHANNESEN, Ph.D. (Johns Hopkins), of the United States Geological Survey, has been appointed assistant professor of mineralogy and petrography in the University of Chicago.

DR. CHARLES C. MCFARLANE, principal of the Brockport State Normal School, and formerly professor of geography, has been appointed to the newly-created office of comptroller in Teachers College, Columbia University.

MR. R. C. PUNNETT, superintendent of the Museum of Zoology at Cambridge University, has been elected to the professorship of biology recently vacated by Professor W. Bateson.

DISCUSSION AND CORRESPONDENCE

THE SOUTHERNMOST GLACIATION IN THE UNITED STATES

IN a recent number of SCIENCE[1] H. W. Fairbanks and E. P. Carey report evidences of "Glaciation in the San Bernardino Range, California," in latitude about 34° 7′ N. Concerning this interesting discovery the writers say: "it has hitherto been assumed that the southernmost point of glaciation in the United States was in the Sierra Nevadas, nearly two hundred miles to the north" (north of latitude 36° N.). If their observations are correct, they have found the most

[1] January 7, 1910.

southern instance of satisfactory evidence of glaciation in this country, so far as I recall; but there are several records of glaciation farther south than the point in the Sierra Nevada referred to by them. Brief references to these may be of interest.

SCIENCE for November 22, 1901,[2] contained a "Note on the Extinct Glaciers of New Mexico and Arizona," by George H. Stone, in which he reported evidences of glaciation in one of the Rocky Mountain Ranges "as far south in New Mexico as a point not far north of Santa Fé" (latitude about 35° 41′). In a later paragraph we read:

> The farthest south and west I have found traces of extinct glaciers is at Prescott, Arizona. Around Prescott are numerous moraines. The highest part of the névé of this glacier could not have been much above 9,000 feet. The central part of the glacier is approximately in n. lat. 34° 30′. The occurrence of an ancient glacier so far south as this was probably due to a very great snowfall owing to the proximity of the ocean. . . . Probably there were then small glaciers in some of the cirques of northern exposure among the mountains directly southeast of Prescott.

R. D. Salisbury published an article on "Glacial Work in the Western Mountains in 1901," in volume 9 of the *Journal of Geology,* 1901. Beginning with page 728 is a brief description of glacial features in the mountains near Santa Fé, between 35° 45′ and 36° north latitude. Some 50 cirques were found, and about 80 ponds and lakelets. One of the glaciers had a length of seven miles. Moraines, striæ and roches moutonneés were observed. In 1902 I had an opportunity to visit this same region, and I entertain no doubt as to the ample proof of local glaciation in those mountains.

In the *Journal of Geology* for 1905[3] is a paper by Wallace W. Atwood on the "Glaciation of San Francisco Mountain, Arizona." This writer describes and figures terminal and lateral moraines, and an outwash plain, and reports the occurrence of striated boulders and polished and grooved bedrock. I have briefly mentioned evidences of glaciation on this same peak, attributing a somewhat greater amount of erosive work to the glacier than is recognized by Atwood, and mentioning what I then believed to be a terminal moraine located near the mouth of a cirque.[4] The latitude of San Francisco Mountain is about 35° 21′ N.

F. J. H. Merrill reports in SCIENCE for July, 1906,[5] "Evidences of Glaciation in Southern Arizona and Northern Sonora." In the vicinity of Nogales, and elsewhere, were found deposits which he believed to be of glacial origin, while the surface had "the rolling topography and pitted surface of a moraine." Nogales is in latitude 31° 20′ N.

The above references may be but a partial list of the published reports of glaciation south of the point in the Sierra Nevada referred to by Fairbanks and Carey; I have made no effort to prepare a complete list. Of these reports, the one on glaciation near Nogales is the most striking, because of the low latitude and low altitude in which the deposits are found. The evidence as reported does not appear sufficiently convincing, in view of the strong probabilities against the occurrence of glacial deposits in the region in question. Merrill's descriptions suggest a landslide origin for the deposits which he took to be glacial. With reference to the glaciation of San Francisco Mountain I wish to add the following paragraphs.

On my visit to San Francisco Mountain I ascended the volcano by the northwest slope, and I descended into the northwestern part of the "crater." I was impressed with the cirque-like form of the depression, and came to the conclusion that the original crater had been destroyed by stream and glacial erosin, and that the encircling cliffs were to be regarded as cirque-walls rather than as crater-walls. The great central depression of the volcano consisted of several more or less distinct cirques uniting downstream. Near the mouth of one of these was what I interpreted as a crescentic terminal

[2] Vol. 14, p. 798.

[3] Vol. 13, p. 276.

[4] *Technology Quarterly,* Vol. 19, p. 410, 1906.

[5] Vol. 24, p. 116.

moraine, rising 150 feet or more above the valley floor. But there were certain associated features which puzzled me at the time. Upstream from the supposed moraine the floor of the cirque appeared to be deeply buried by an accumulation of rock débris which was generally as high as and near the head of the cirque distinctly higher than the morainal ridge. This débris was in places, especially near the marginal walls, arranged in parallel ridges trending with the axis of the valley; and in the depressions between the ridges were patches of snow and some small ponds. Thus the moraine had a steep frontal slope, but at the back merged with the ridged rock débris which rose to still higher levels. There were some depressions in the rock débris, 25 to 40 feet deep, which I took to be ice-block holes. No bedrock was seen in the cirque floor.

During the recent meeting of the Geological Society of America, Professor H. B. Patton, of Boulder, Colorado, exhibited some photographs of the rock streams of Veta Mountain, Colorado. One of these photographs showed the high and steep front terminus of a rock stream, and resembled very closely the front slope of the supposed moraine in the San Francisco cirque. Others of his pictures showed the longitudinal parallel ridges which characterize some rock streams, with bands of snow lying in the hollows between the ridges, just as was the case in the San Francisco cirque at the time of my visit. If the concentric wave-like ridges pictured by Howe[6] were present in the San Francisco deposits, I did not notice them.

I am inclined to believe that the features which puzzled me at the time of my visit may have been due to landslides or rock streams. This does not mean that the depression in which the features occur is not a glacial cirque; nor that the moraines reported by Atwood are not true moraines. It simply means that I am not wholly satisfied with the evidence of glaciation as reported by myself. It would seem that the possibility of a landslide or rock stream origin for features apparently due to glaciation must be carefully considered, especially when glaciation in doubtful localities is involved.

D. W. Johnson

[6] "Landslides of the San Juan Mountains," U. S. G. S. Professional Paper, No. 67.

THE TEACHING OF ELEMENTARY DYNAMICS IN THE HIGH SCHOOL

To the Editor of Science: I have just finished reading "The Teaching of Elementary Dynamics in the High School," by Wm. Kent. I believe that Mr. Kent is right in most respects except his last paragraph, where he states: "It is high time they [teachers of physics in the high schools] change their methods and try the method that was successfully used fifty years ago." As one of the physics teachers in secondary schools, I wish to say that my own practise for many years has not been materially different from that of Mr. Kent and I wish to put in just a word for the most of the physics teachers of my acquaintance when I say that their practise and that of Mr. Kent do not differ in any essential particular.

Again and again the discussion of the *force* $=$ *mass* $\times$ *acceleration* formula has come up among groups of teachers and, in every case, the verdict of the teachers has been that it was not a formidable matter. Each knew a way to teach it so that the pupil got the gist of the matter even if he could not write a text-book on it afterwards. And this is true whether the instruction is given in English or metric units. One is as easy as the other.

Mr. Kent has evidently assumed from the large amount of discussion on this question of dynamics (kinetics) that there is something radically wrong with the teaching of secondary school physics and that the chief cause of any lack of efficiency is to be laid at the door of that one little formula—$f = ma$. We all may easily observe that those who are doing the teaching are not the ones who are doing the talking. It might be as readily discovered that the great majority of teachers are going ahead in a reasonably sensible way and are teaching physics (and other subjects as well) according to the dictates of common sense

without undue regard to "requirements" of any kind.

All *teachers* of physics, whether in the secondary school or the college are under great obligations to Mr. Kent for his clear, excellent and simple explanation of this debated subject.

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NOTE ON FREE PUBLIC MUSEUMS

WHILE reading Mr. Henry L. Ward's very excellent paper on "Modern Exhibitional Tendencies of Museums of Natural History and Ethnology designed for Public Use," recently published,[1] the following interesting statement was noted:

> In fact, to the best of my knowledge, the Public Museum of the City of Milwaukee was the first institution of this nature to throw open its doors for the free admission of the public on every day of the year, a regulation to that effect having been adopted and put into force in December, 1905.

It is exceedingly gratifying to note that this progressive institution has been among the first to recognize that public museums are for the people and that all should be admitted freely with as little hindrance as possible. In this commendable movement, however, the Chicago Academy of Sciences has about ten years' priority over the Milwaukee Museum, its doors having been continuously open to the public since October 1, 1894. The hours are 9 A.M. to 5 P.M. week days and 1 to 5 P.M. Sundays. It is interesting to note that the Willner bequest of $100,000 recently received by the academy was won because the children were allowed free access to the building, especially on Sunday afternoons, and were given more or less attention. Mr. Willner once said to a friend, as he observed the interest of the children in the museum exhibits, "I think this institution is deserving of support." The fact that the academy received one third of his fortune is ample evidence that he believed in the educative value of institutions of this character.

FRANK C. BAKER

[1] Trans. Wis. Acad. Sciences, Arts and Letters, XVI., pp. 325–342, 1908.

SCIENTIFIC BOOKS

The Theory of Electrons and Its Applications to the Phenomena of Light and Radiant Heat. By H. A. LORENTZ.

This book is based upon the course of lectures delivered by Professor Lorentz at Columbia University in March and April, 1906. But the author has introduced into the book considerable material not given in the lectures and has also given in the form of notes many mathematical proofs which were omitted in the lectures.

It was naturally expected that this book by an author, who is himself responsible for a large part in the remarkable development of the modern theory of electrons, would prove of absorbing interest to physicists and to those in general who have any knowledge of the importance and fascination of the subject. As was expected, this is the case.

The author states in his preface that he is perforce obliged to restrict himself greatly in discussing the applications of the theory as to the number of topics considered, and remarks that the work of Voigt on magneto-optical phenomena, of Planck on radiation, and of Einstein on the principle of relativity, has not received the attention which its importance would justify. The scope of the book will to some extent be revealed in the present brief review.

In the first chapter the fundamental formulæ of the electron theory are derived from Maxwell's well-known theory, with the aid of auxiliary hypotheses which the nature of the subject demands. Referring to Maxwell's equations, the author calls attention to the fact that, while they are useful and adequate in the treatment of many problems, there are yet many problems for which they are not. He goes on to say:

> Moreover, even if they were so, this general theory, in which we express the peculiar properties of different ponderable bodies by simply ascribing to each of them particular values of the dielectric constant, the conductivity and the magnetic permeability, can no longer be considered satisfactory when we wish to obtain a deeper insight into the nature of the phenomena. If we wish to understand the way in which electric and magnetic properties depend on the temperature,

the density, the chemical constitution or the crystalline state of substances, we can not be satisfied with simply introducing for each substance these coefficients, whose values are to be determined by experiment; we shall be obliged to have recourse to some hypothesis about the mechanism that is at the bottom of the phenomena. It is by this necessity that we have been led to the conception of electrons, *i. e.*, of extremely small particles, charged with electricity, which are present in immense numbers in all ponderable bodies, and by whose distribution and motions we endeavor to explain all electric and optical phenomena which are not confined to the free ether.

After the development of the fundamental equations, the first chapter is chiefly devoted to the general properties of free electrons. Use is made of the quantity named by Abraham the electromagnetic momentum and employed by him in his "Prinzipien der Dynamik des Electrons." The interesting question of the electromagnetic mass of the electron receives comprehensive treatment, in which the necessary distinction between "longitudinal" and "transverse" mass is very clearly brought out. With a view to their subsequent application in connection with the influence of the earth's motion upon optical phenomena the fundamental equations for a moving system are derived. The chapter closes with a brief review of Drude's theory of the conduction of electricity in metals, and of a revised form of this theory, proposed by the author, and considered by him to be somewhat more rigorously developed than that of Drude.

In the second chapter the subject of emission and absorption of heat is discussed from the standpoint of electron theory, with the view of indicating how far this theory may lead toward the elucidation of the mechanism involved in the phenomena.

Reference is made to the classical work of Kirchhoff, Boltzmann and Wien in connection with black body radiation, and it is remarked that the results obtained by Boltzmann and Wien represent all that could be expected from the methods of thermodynamics and general electromagnetic theory, and that these results afford small clue to the discovery of the real nature of the mechanism of emission and absorption.

Planck's theory of radiation is then discussed. As is well known, this theory is based on the assumption that every ponderable body contains a very large number of electromagnetic resonators. Different resonators may have different natural frequencies. In order to arrive at his well-known radiation formula, Professor Planck assumes that each resonator possesses the peculiar property of being able to receive or give up energy in definite finite amounts only, and not gradually. Many who have attempted to follow Professor Planck's arguments in the development of his theory have found their chief difficulty in this assumption. In view of this fact, the concluding remarks of the author are of particular interest. Referring to Planck's theory, he says:

> Yet, we can not say that the mechanism of the phenomena has been unveiled by it, and it must be admitted that it is difficult to see a reason for this partition of energy by finite portions, which are not even equal to each other, but vary from one resonator to another.

Professor Larmor in the Bakerian lecture of November 18, 1909, referring to Planck's theory, also calls attention to the same difficulty.

The author goes on to develop an electron theory of radiation for metals, and arrives at a formula, valid for long waves, which is in agreement with Planck's for this case.

Finally, Jeans's theory of radiation is briefly reviewed. This theory, as is well known, is based on the assumption that the mechanical theorem of equipartition of energy is applicable to modes of vibration in the ether, and it furnishes a radiation formula which for long waves also agrees with Planck's for this case. The author's concluding remark is again of much interest:

> I shall conclude by observing that the law of equipartition which, for systems of molecules, can be deduced from the principles of statistical mechanics, can not as yet be considered to have been proved for systems containing ether.

Professor Larmor in the lecture referred to above refers to the well-known controversy concerning this matter.

Chapters III. and IV. are devoted to an extended discussion of the Zeeman effect and of the propagation of light in a body composed of molecules. In concluding, the author remarks on the inadequacy of the theory in its present state, and cites the experiments of Wood on sodium vapor, and those of Humphreys and Mohler indicating the shifting of spectral lines by pressure, as beyond the power of the present theory to explain.

In chapter V. optical phenomena in moving bodies are considered. Fresnel's classical work in this connection is reviewed, likewise Stokes's theory of aberration with Planck's well-known amendment. The theory of electrons is applied to the deduction of Fresnel's coefficient. The Michelson-Morley experiment is discussed, and its negative results explained on the assumption of the Fitzgerald-Lorentz shortening effect. The negative results of Rayleigh and of Brace in looking for double refraction due to the Fitzgerald-Lorentz shortening effect are explained on the author's theory of corresponding states for a fixed and moving system. Abraham's results on the energy of a moving electron are discussed. The question of form of the moving electron is also considered; and the difficulty is brought out of reconciling the rigid spherical electron of Abraham, or the electron deformed by motion into an ellipsoid having the original volume, proposed by Bucherer and by Langevin, with the experiments of Rayleigh and of Brace on double refraction in moving bodies. The author's well-known electromagnetic equations for a moving system are derived, and the interpretation which has been given to his results by Einstein in the theory of relativity is clearly brought out.

Even the non-mathematical reader will not find unusual difficulty in reading this book. For the text itself is devoid of intricate mathematical proofs. Those who are interested in following through the analysis involved in the demonstrations of the formulæ employed in the text are referred at the appropriate times to the mathematical notes at the end of the book. Throughout, the reader meets with the usual clear methods of exposition so characteristic of all the author's writings. The book is in English and published by the firm of B. G. Teubner, Leipzig.

A. P. WILLS

Taschenbuch für Mathematiker und Physiker. Unter Mitwirkung von FR. AUERBACH, O. KNOPF, H. LIEBMANN, E. WÖLFFING, u. A. herausgegeben von FELIX AUERBACH. 8vo, pp. xliv + 450. Leipzig und Berlin, Teubner. 1909. 6 Marks.

While the chemists, astronomers, engineers and other professional orders have long possessed pocket manuals for handy reference, a similar convenience has not been provided for mathematicians and physicists. The present little volume supplies this want in a considerable degree, and compresses into a small space a remarkable mass of useful information. The "Taschenbuch" will be issued annually, with constant variation of subjects treated so as to cover eventually as wide a range as may be desirable. The first volume, for 1909, has been delayed by circumstances incident to a new undertaking, but future issues are expected to appear early in each year.

A brief notice of Kelvin's work, accompanied by a portrait, opens the volume. There follow a calendar for the year 1909, several useful tables of astronomical, geographical and other constants, and four-place tables of logarithms, trigonometric and hyperbolic functions, squares and Bessel functions. These conclude the introduction, pages i–xliv. The body of the manual is divided between Mathematics, pages 1–160; Mechanics, pages 161–203; Physics, pages 204–350, and General Chemistry, pages 351–369. Later come lists of mathematical and physical journals and of recent publications, a necrology, the roll of teachers in the higher German institutions of learning and a good index of the volume.

Subjects reserved for treatment in later issues are indicated in the text. Under Mathematics are at present included the fundamentals of arithmetic, theory of numbers, algebra, determinants, theory of groups, infinite series, differential and integral calculus, definite integrals, differential equations, calculus of

variations, theory of functions, elliptic functions, geometry and trigonometry, analytic geometry of plane and space, differential geometry, probabilities, calculus of errors, quaternions and vector analysis. Under each of these and other topics is a brief summary of the subject, often containing items that are not elsewhere so easily found.

Mechanics and Physics cover a wide range: Lagrange's equations, spherical harmonics, graphical statics, work and energy, hydrodynamics, elasticity, heat, sound, light, electric units, laws and measurements, electromagnetism, induction, hysteresis, Maxwell's theory, etc. Numerous tables accompany the text.

In arrangement and style the "Taschenbuch" reminds one of Pascal's "Repertorium of Higher Mathematics." It is, however, only about one third as large, and in mathematical content only one ninth. All references have been excluded under the heavy compression. But every mathematician and physicist will find it a useful book to have about, for it will often save searching through a library for an elusive item.

F. N. COLE

Vergleichende Anatomie der Wirbeltiere. DR. ROBERT WIEDERSHEIM. Seventh edition. Pp. 936, 476 figures, one plate. Jena, Gustav Fischer. 1909.

The rapid growth of this book, which now contains nearly a thousand pages and costs between five and six dollars, has transformed it from a text-book into a reference work. As such it will without doubt be as indispensable as in previous editions. It retains, however, much the same character as before.

It is pleasing to an American to note the large recognition of American work, but one regrets that in one or more instances the facts are recorded in footnotes only.

The text is brought up to date by the addition of new material on almost every page and certain sections are essentially rewritten, as for example, the discussion of the lymphatic system, which is more than twice as large as before. The chapter upon the skull has grown the most owing to a large degree to the introduction of more figures of chondrocrania. The section upon myology ought, it seems to the writer, to have received more attention than it has had. The subsection upon the electrical organs certainly ought to have been rewritten so as to embody recent discoveries. The sections upon the central nervous system, sense organs and the respiratory system have expanded about equally. The discussion of the peripheral nervous system is but slightly longer, but it has been largely rewritten and is greatly improved.

The sixty new figures are well chosen. A considerable number of illustrations which have appeared in several editions could well be dispensed with, and the printing of many of the old figures in colors has added little if at all to the usefulness or beauty of the book.

The bibliography has been thoroughly revised, a very large number of new titles have been added, and, owing to the omission of many of the older or less important titles, there has been only a small increase in size.

This edition can be heartily commended.

LEONARD W. WILLIAMS

Lectures on the Experimental Psychology of the Thought-Processes. By EDWARD BRADFORD TITCHENER. New York, The Macmillan Company. 1909. Pp. xi + 318.

In these lectures, originally delivered at the University of Illinois in the spring of 1909, and now published with an appendix containing valuable notes and references, Professor Titchener presents a résumé and criticism of a much-debated recent development in experimental psychology—an attempt to extend the experimental method to the processes of thinking. The extended series of articles which are chiefly considered—though contributions by other psychologists receive due notice—have emanated from the pupils and colleagues of Professor Külpe at Würzburg. The principal names are Marbe, Watt, Ach, Messer and Bühler, and the dates run from 1901 to 1908. Many other writers, whose work or views bear on the problem, are considered in the notes or in the two introductory lectures.

The early experimental psychologists considered the higher intellectual processes too

complex for experimental control, and it is of interest to discover whether this early judgment is now superseded, and whether, quite apart from results, a method has been devised for experimenting on thought. The method now suggested is certainly direct and obvious. The person whose mental processes are to be observed is given a problem to solve; in some experiments the problem has been of the easiest, in others it has demanded careful attention; but in all cases it has been such that a solution could be reached in a few seconds, at the end of which time the thinker is required to describe what had passed through his mind in the process of solution. It is essential to the method that the same general sort of problem be set many times in succession, and that the preliminary consciousness intervening between the signal "Ready!" and the propounding of the particular problem should be described, as well as the consciousness transpiring between the propounding of the problem and the attainment of the solution. Whatever else may be said of the method, it has at least produced a large mass of data regarding matters which had previously been the subject of only casual observation. The method has been sharply criticized by no less an authority than Wundt, on the ground that it does not fulfil the essential requirement of experimental observation. In a proper experiment, as Wundt says, the observer knows beforehand exactly where his attention must be directed; the field of observation is narrowed, and the observation is consequently more minute and accurate than in ordinary circumstances. In this new work, however, the observer, who is also the person experimented on, does not know beforehand exactly what he has to observe, and, besides, must devote his attention first of all to the solution of his problem, and only secondarily to the observations which are desired. With this line of criticism, which is evidently the old, familiar objection to introspection in general, our author seems not to agree. He regards the work so far done as a promising beginning, except that too much has been attempted at once, and that some of the experimenters have been contented with observations on what the thought was about, instead of insisting on a description of the thought as a mere conscious fact.

As to the results of this work, one at least has been gained, and is freely admitted by Professor Titchener. It will be remembered that the problems set in any one series were of one general nature, which was understood beforehand. The thinker becomes adjusted to this general task, as is shown by the fact that the propounding of the particular problem is usually followed promptly by a course of thought leading to or towards the solution, to the exclusion of numerous other associations which might otherwise be recalled by the words, etc., used in putting the problem. The preliminary adjustment limits or directs the play of association. Yet, usually, no consciousness of the nature of the task can be detected in the interval between the setting of the particular problem and the reaching of the solution. What consciousness there is of the nature of the task comes in the preliminary period, after the ready-signal; and, even here, as the series of similar problems progresses and the task becomes familiar, the consciousness of it tends to be reduced, and finally to disappear, though the adjustment to the task is all the time improving. This result is valuable both as illustrating the relation of consciousness to mental function, and as indicating a dynamic factor in thought. In both respects, the result is not entirely new, having been foreshadowed, in another field, by conclusions of some of the early students of reaction times (Exner, Cattell, Lange); but it has now received a much wider extension.

Another curious result is the frequent occurrence, in these experiments, of states of mind in which one is clearly aware of the task in hand, or of the solution, or of some other fact, but is unable to detect any image or sensation, or anything which can be described except as the "thought of" so and so, or the "knowledge that" so and so. Some of the experimenters, particularly Bühler and the present reviewer, have been content to regard this description adequate, and to conclude that such "thoughts" were elements of

consciousness, irreducible to complexes of sensations and images, and of a kind hitherto unrecognized by most psychologists. Our author disbelieves altogether in the elementary character of such thoughts; he emphasizes the crudeness of the methods employed, and believes that more refined study will probably reveal vestiges of images and sensations of bodily attitudes, as components of what has been called imageless or non-sensorial thought.

In addition to its main purpose, the book is valuable as throwing a clearer light than any of his previous writings on the author's guiding principles in psychologizing.

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SOME SUGGESTIONS FOR THE STUDY OF COMETS[1]

Comets are, probably, the most mysterious of all celestial objects. Whence they come; whither they go, when they leave forever; where they gather fresh material, if they do, and how; their mechanical structure; the forces that commonly bind them together; the other forces that sometimes tear them apart; the origin of the curious knots, twists and streaks in their tails; and why it is that they are self-luminous, are among the things concerning comets we should like to know, but which, at present, no physicist and no astronomer can tell us.

It is but natural therefore that the return and near approach of Halley's comet should arouse unusual interest and activity in the study of these strange objects, for it is bringing us a rare chance, especially if, as seems likely, the earth should pass through its tail, of learning much that we would like to know in regard to comets and their accompanying phenomena. But to make such a study most efficient it is necessary to consider what phenomena may possibly be expected, and how they can be observed.

These form two distinct groups, namely: (1) celestial, astrophysical in the main; (2) terrestrial, chiefly meteorological. Among the former are:

(*a*) *Gross Appearances.*—This includes all distinctive markings, such as bright patches; streaks, both straight and twisted; number, direction and shape of tails; time and manner of beginning and ending of tails; and any other such phenomenon as may present itself to the observer. A photographic record, as nearly as practicable continuous, should be taken of these phenomena for future study, but it would be well to supplement the photographs by numerous eye observations.

Any one expecting to do work of this nature, and there are many observatories adequately equipped for it, would do well to consult Professor E. E. Barnard, of the Yerkes Observatory, either directly or through his papers on comets.

(*b*) *Spectrum.*—Visual and photographic analysis of the light should be applied to the comet in detail—to the jets and envelopes in and about the head, to the streaks in the tail and to all portions bright enough to yield results.

Such a program, while of decided value, can not profitably be undertaken except by those observatories especially well equipped for this sort of work.

(*c*) *Polarization.*—It is known that the light of comets is polarized to some extent, from which it is inferred that a part of their luminosity is due to reflected sunlight, but this phenomenon needs further examination, and, in particular, separation from sky polarization. It would be well to compare the polarization of that part of the comet where a right angle exists between the directions from it to the sun and the earth, respectively, with the polarization of other portions. If the particles of the comet are small in size, compared with the cube of an average wave-length of light, then, as Rayleigh has shown, there will be

[1] This paper was prepared at the request of the comet committee of the Astronomical and Astrophysical Society of America for inclusion in its circular respecting observations of Halley's comet. Through causes for which its author is in no way responsible it did not reach its destination in time to be so used and the committee now seeks to give it publicity through the pages of Science and such other journals as may choose to reproduce it.

marked polarization that is a maximum in a direction at right angles to the incident radiation. It is true that we have in the turning of the tail always away from the sun strong evidence (since this is due, we believe, to light-pressure) of the minute size of the luminous particles; but, nevertheless, such evidence as the phenomena of polarization can give on this point is worth having.

It would also be desirable to determine the relative amount of reflected to intrinsic light, though the method of accurately doing this is not obvious.

Polarization work can be done with any *refracting* telescope of large light-gathering power. A reflecting telescope could not be used for this purpose because of the polarization effects that it itself would introduce.

(*d*) *Light-fluctuation.*—It is well known that the light of comets often varies irregularly and without obvious cause. These variations should be studied in connection with the formation of jets and envelopes, and especially observed to see where the changes in brilliancy have their origin and how rapidly they spread to other parts.

The position and size of sun spots, and other solar phenomena, should also be observed and studied in connection with the light changes. Evidently the luminescence of comets is, in some way, largely dependent upon the sun, and it has been claimed that it is greatest during periods of sun-spot maxima. If so, then it may change with the size and orientation of the spots. At any rate, this is a phenomenon that can easily and, perhaps, profitably be studied with the aid of even a very modest equipment.

All the above phenomena can be observed at any time the comet is brightly visible, but there are a number of other phenomena which possibly may appear or be modified during the passage of the earth through its tail, if, fortunately, such an occurrence should happen, and which, therefore, ought to be carefully watched at that time. These form the second or terrestrial group, above mentioned, some of which are:

1. *Electrical Potential.*—In reality it is the difference between the electrical potentials of two points a given vertical distance apart in the atmosphere that is here referred to. This would be modified by the bringing of an electrical charge from some extraneous source to the atmosphere, and, conceivably, might therefore help to give some idea of the electrical condition of that part of a comet's tail through which we happened to pass. But, as the electrical state of the atmosphere changes so greatly from place to place and from day to day, it does not seem that observations of this nature can afford much definite information.

2. *Atmospheric Conductivity.*—This comes, essentially, to the same thing as the ionization of the atmosphere, and would be modified by the entrance into the air of charged particles or other ionizing agents.

Like the electric potential of the air this too is subject, ordinarily, to such changes that, seemingly, no trustworthy inference in regard to the electrical condition of a comet's tail, should we pass through one, could be drawn from such observations.

However, if any one, not entirely familiar with them, wishes to take up either or both of these lines of work he will find Gockel, "Die Luftelektrizität," a good guide.

3. *Damping of Electrical Waves.*—It is well known that the distance a wireless message can be received changes irregularly, owing, presumably, to the intensity and distribution of the ionization of the atmosphere. The ease or difficulty of transmitting wireless messages, especially over the ocean, say from San Francisco to Honolulu, might, therefore, give some hint about the electrical state and the ionizing action of the material of a comet's tail through which the earth at that time might chance to be passing. Probably the hint would not be a very distinct one, but observations of this phenomenon seem to the author much more promising of results than do those of either the potential or the conductivity of the atmosphere.

4. *Earth Currents.*—A marked change in the electrical condition of the atmosphere is likely to lead to earth currents of greater or less magnitude. It might therefore be well to

request telegraph and telephone companies to report any such disturbances as may occur during our passage through the comet, should this happen. However, such currents should be considered only in connection with other phenomena, since alone they can have but little meaning.

5. *Diurnal Variation of the Earth's Magnetism.*—It has been known for a long time that there is regularly both a diurnal and a semidiurnal variation in all the elements of terrestrial magnetism; and it has been shown by Schuster[3] that the origin of these daily disturbances is outside the surface of the earth. The origin of this variation is, probably, the Foucault currents caused by the sweep of the ionized, and therefore conducting, air across the lines of magnetic force. The more ionized, or the better conducting the air, other things being equal, the greater these currents and, if this theory is correct, the greater the resulting diurnal variation in the records obtained at magnetic observatories.

If then the particles of a comet's tail are highly electrified, or should in any way produce, on our coming into them, an ionizing action on the atmosphere, there must result corresponding changes in the diurnal variations. The action of the cometary particles, presumably, would be on the outer layers of the atmosphere where any change in the conductivity is most effective. Also since, in general, the winds increase with latitude and the lines of magnetic force become more concentrated and more nearly vertical, therefore any change in the diurnal variation, especially of the declination, that may be due to the action of a comet's tail probably would be most marked in the higher latitudes.

It seems, therefore, that it would be especially well to study and compare the diurnal variations obtained at the many excellent magnetic observatories just before, during and just after the coming passage of the earth through the tail of Halley's comet—assuming, of course, this event to take place.

6. *Auroral Displays.*—Auroras serve as rather delicate indicators of the electrical state of the outer atmosphere, and therefore should be carefully watched for and minutely noted during a continuous period of several days equally overlapping the supposed epoch of our intersection with the material of the comet.

7. *Line and Band Absorption.*—The atmospheric absorption lines and bands furnish about the best means we have for detecting changes in the composition of the atmosphere, especially of the outer portions. Therefore it may be desirable to compare the atmospheric lines and bands during the passage of the earth across the comet's tail with the lines and bands obtained at other times.

If the electrification of the outer air is materially changed during this passage there may result a corresponding temporary change in the amount of ozone in that region, that perhaps could best be detected through the great ozone absorption band[3] at wave-lengths $9\,\mu$ to $10\,\mu$.

8. *Atmospheric Transmission.*—In reducing the data obtained with integrating pyrheliometers it is customary to use, with certain corrections, the simple Bouguer equation,

$$I = I_0 a^m,$$

in which I is the observed solar intensity through the air mass m, I_0 the intensity outside the atmosphere, and a the coefficient of transmission. This latter varies from day to day, but, assuming it to remain constant for a few hours, can be determined by observations taken with different values of m, or, as Kimball[4] has shown, by a single observation of the intensity, together with a simultaneous measurement of sky polarization.

Since a is such a variable quantity its determination while, perhaps, of some value in this connection, can not be regarded as very promising of definite information concerning the material of a comet through which we might be passing.

9. *Meteoric Trails.*—Since the particles com-

[3] *Phil. Trans.*, A, Vol. 180, p. 467, 1889; Vol. 208, pp. 163–204, 1908.

[3] Angström, *Arkiv för Matematik, Astronomie och Fysik*, 1, 395, 1904.

[4] *Mount Weather Bulletin*, 2, pp. 55–65, 1909.

posing the tail of a comet presumably are excessively minute, any meteoric trails they may produce on coming in contact with the atmosphere must be small. However, it would be well, at the proper time, to watch for them with a telescope pointed nearly vertically and focused for a distance of from 100 to 150 miles. Presumably only faint scintillations, probably entirely too faint to be seen, need be expected, but only by such observations can we know definitely just what does or does not take place.

10. *Bishop's Ring.*—After the explosion of Krakatoa, and also after that of Mount Pelé, a faint reddish brown ring of the coronal type was seen about the sun. Its inner radius was about 12°, and its outer approximately 22°. It was due, almost certainly, in both cases, to finely divided matter thrown up to great altitudes and from there spread widely over the earth. The mean radius of these particles, assuming them spherical in shape, has been calculated to be about equal to the largest visible wave-length. They were therefore excessively minute, and it is possible that after passing through the tail of a comet something of this kind may be seen; at any rate, careful observation should be made for it, after such an event, by those of exceptionally sensitive eyes. Such observations are best made with the sun hidden behind an opaque object.

11. *Color of the Sun.*—The color of the sun, as is well known, depends upon the size and number of solid or liquid particles through which it is seen, and therefore may, possibly, be temporarily modified on our passing through a comet's tail.

12. *Atmospheric Polarization.*—This phenomenon depends mainly upon the scattering of sunlight by any minute particles in the atmosphere. The percentage of the polarized to the total sky light at any part of the sky, say where the polarization is a maximum, or 90° from the sun on the vertical circle passing through it, is a function of the dust content of the air. This percentage therefore should be carefully noted during our supposed coming passage through the tail of Halley's comet, as should also the positions of the so-called neutral points of Arago, Babinet and Brewster—the first especially, as it is the easiest observed and most accurately determined.

It might also be advisable to observe the polarization percentage of different colors, by the aid of suitable screens, since this depends upon the size of the particles that scatter the light.

13. *Twilight Phenomena.*—Twilight colors, and the gamut of changes through which they run, clearly are dependent upon the dust content of the atmosphere, as was strikingly evident after the eruption of Krakatoa, and therefore might, possibly, afford some information in regard to the tail of any comet through which the earth may pass.

14. *Luminous Clouds.*—After the eruption of Krakatoa there was seen for many years, but only in latitudes of 45° or more, faintly luminous clouds of, seemingly, great altitudes.

It is not at all certain that these so-called clouds were due in the least to the volcanic eruption; but still they should be closely looked for at the time of and after our passage through a comet's tail, since they might be modified by the material thus picked up.

15. *Number of Dust Particles in the Air.*—The number of dust particles, especially in the outer portions of the atmosphere, may be greatly increased by the passage of the earth through the tail of a comet. Therefore it would be well to count the particles of dust per cubic centimeter say of air on the tops of high mountains, and in samples obtained by sounding balloons, before and just after the time of our entrance into the tail of Halley's comet.

16. *Zodiacal Light.*—While our knowledge of the zodiacal light, of the nature and location of the material to which it is due, and how this material is rendered luminous, is practically nil, it seems quite possible that its real or apparent brilliancy may be greater during our passage through even so rare a substance as the tail of a comet. Therefore the details of this phenomenon too should be recorded, at the proper time, by those so situated as to observe it to good advantage.

17. *Gegenschein.*—But little is known of the

cause or location, except in direction, of the *gegenschein*, but it seems not improbable that it may be more distinctly visible during the passage of the earth through the luminous particles of a comet's tail, and therefore it should be studied, at the proper time, with the greatest care by those in the habit of observing it.

18. *The Auroral Line.*—Arrhenius[8] says:

> Whichever way we turn the spectroscope on a very clear night, especially in the tropics, we observe this peculiar green line. (The so-called auroral line.) It was formerly considered to be characteristic of the zodiacal light, but on a closer examination it has been traced all over the sky, even where the zodiacal light could not be observed.

Evidently the source of this line is not definitely known, but, conceivably, it may be rendered more brilliant by the passage of the earth through the tail of a comet, and therefore it would be well for some favorably situated observer carefully to measure its brilliancy on several consecutive nights, so selected as symmetrically to overlap the calculated date of our supposed passage through the tail of Halley's comet.

The most promising, in this connection, of the above phenomena are, in the author's opinion, those designated as *a, b, c, d,* 5, 6, 9, 10, 13, 16 and 17.

The above is not claimed as a complete list of the phenomena that may be associated with a comet, but it is hoped that they, together with others that they may suggest, will soon give us a better understanding of comets in general and of Halley's in particular.

W. J. Humphreys
Mount Weather Observatory,
Bluemont, Va.

SPECIAL ARTICLES

SOME LONG-PERIOD DEVIATIONS OF THE HORIZONTAL PENDULUMS AT THE HARVARD SEISMOGRAPHIC STATION

The studies of Omori, Milne, Denison and many others, on the movements of horizontal pendulums due to other than seismic or microseismic causes, suggested a similar study of the movements shown by the pair of Bosch-Omori instruments at the Harvard station. These pendulums, which stand at right angles to each other on the meridian and parallel of the station, record through small tracers on sheets of smoked paper carried by drums that complete a revolution once in an hour. The drums travel laterally, causing each hour's record to appear as a single line spaced about an eighth of an inch from its neighbor on either hand. A complete day's record, undisturbed by seismic or other movements, appears as a series of twenty-four parallel lines. Any long-period deviations of the pendulums, therefore, are shown by a crowding of these lines toward one side of the sheet or the other.

The study was made to determine whether or not solar or cyclonic and anticyclonic conditions affect the pendulums, as has been suggested. Lack of time prohibited an investigation of tidal and other effects, except so far as to prove them entirely subordinate to the main controls. The records were examined for the months of April, May, October, November and December, 1908. The pendulum standing on the meridian of the station (the east-west component, so-called) is most sensitive, in the matter of long, non-periodic movements, to forces applied due east or west of the station. The same is true of the north-south component in reference to forces applied on the north or south.

Two types of deflection are shown by each component:

The E.-W. Component: Type 1.—A diurnal deflection. This is indicated by a more or less strong tendency of the pendulum to move east during the forenoon and west later in the day. It begins about sunrise, the more or less steady easterly travel dying out about noon and later becoming a westerly travel which often lasts well into the night. This type of deflection never persists from one twenty-four hours into the next; it occurs only on days when the sun shines, and is best shown on the least cloudy days. When the diurnal quality of the thermograph curve is most marked, the pendulum

[8] "Worlds in the Making," p. 116.

records the strongest diurnal deflection. Some kind of solar control seems necessary to explain these movements. The method of its action has not been made out.

Type 2.—Correlation of the movements of the pendulum with the movements of areas of low and high barometric pressure across the United States and southern Canada, shows an intimate relation between them. An easterly deflection of the E.-W. component begins when an area of low pressure appears in some westerly or southwesterly direction from the station. The cyclone may be even 1,500 or more miles away when the deflection begins. The time of beginning seems to depend partly on the movements of a high-pressure center to the east, though such a relation can not be definitely worked out until more complete knowledge of conditions over the Atlantic Ocean is available. There appears to be at least a general relation between the amount of pressure at the center of the cyclone, the area covered by it, the rapidity of its movement, and the time of beginning and the rapidity of easterly travel of the pendulum. As the depression moves east or northeast, the pendulum also moves toward the east until the cyclone is nearly over the station, and as the depression passes off the coast, the pendulum begins to travel toward the west. Inspection of the current weather map shows an area of high pressure, or one of less intense low pressure, than that which caused the deflection, to be approaching easterly in the western quadrant. As the anticyclone comes nearer, the westerly travel usually increases in rapidity. When the center is approximately over the station, the direction of travel is reversed and the cycle repeated. These deflections occupy any length of time, dependent wholly on the time taken for the passage of the cyclone or anticyclone. They often begin many hours before the barometer indicates the approach of minima or maxima. They do not go on uninterruptedly; there are countless minor variations the causes of which it is as yet impossible to determine. The diurnal deflection is superimposed on these longer, non-periodic deflections.

The N.-S. Component: Type 1.—A diurnal deflection. This is indicated by a more or less strong tendency of the pendulum to move south during the forenoon, and north later in the day. It is much less clearly shown than the diurnal of the E.-W. component, and is apparently dependent on the same causes.

Type 2.—Deflections cyclonically or anticyclonically controlled. These include all movements due to the approach of high or low pressure areas from some westerly direction. They are somewhat less frequent, and usually much less marked, and their period of maximum activity is nearly always much shorter than is the case with the deflections of the E.-W. component. This is apparently due to the parallelism of the N.-S. component to the mean cyclonic and anticyclonic tracks. The approach of a *high* from the northwest and its passage north of the station, or the approach of a *low* from the south or southwest and its passage south, is accompanied by a northward deflection of the pendulum. This reaches its maximum when the pressure gradient runs due north, and becomes a southerly deflection when pressure conditions are reversed. Often interrupting these deflections are temporary movements for a few hours in a contrary direction, followed by the renewal of the long-period travel. These variations do not affect the general tendency, and their causes have not been made out. The diurnal deflection is superimposed on these longer, non-periodic deflections.

The summary presented in the table below shows for each component the per cents of cases (on the basis of numbers of days out of the total) in which the particular deflection occurred. A more desirable basis would be units by cyclones and anticyclones; but the variability of the time taken for the passage of these areas by the station, their complex distributions, and the impossibility of evaluating the share that each has in producing a given deflection, makes it impracticable to determine the limits of any one unit. The per cents. of movements from *lows* toward *highs* are considerably smaller than they would be if computed on the latter basis, for they take

account of temporary reversals in deflection which are lost sight of in the general deflections lasting for an indefinite period.

	E.-W. Component.		N.-S. Component.	
	Deflection from *Lows* toward *Highs*	Deflection from *Highs* toward *Lows*	Deflection from *Lows* toward *Highs*	Deflection from *Highs* toward *Lows*
April......	70.0 %	30.0 %	55.0 %	45.0 %
May.........	95.2	4.8	69.5	30.5
October....	94.7	5.3	62.5	37.5
November.	83.3	16.7	77.7	22.3
December.	100 0	0.0	85.7	14.3
Mean.......	88.5	11.5	69.0	31.0

It will be noticed that the pendulums show greater response to pressure conditions during the fall and winter months than during the spring months. This is to be expected, inasmuch as barometric maxima and minima are best developed during fall and winter. The records for the summer months were not examined critically on this account. The study thus far has been entirely qualitative; quantitative work has been found unsatisfactory owing to the lack of a recording device which shall obviate the running together of the hourly lines at the very frequent times of extreme deflection.

The causes of the movements here described are obscure. Many suggestions regarding the causes of similar movements elsewhere have been made, but no one of them is corroborated as yet by sufficiently wide-spread observation, to warrant its being fully accepted. It would seem that causes which may be operative over long distances must be assumed, for the pendulums at Cambridge show distinct movements in sympathy with barometric maxima and minima when these are still very far distant from the station.

The possibility of using horizontal pendulums in forecasting on windward coasts has been suggested by Mr. F. Napier Denison, of the Meteorological Office at Victoria, B. C. If, as in the case of the Harvard station, horizontal pendulums in general announce the approach of various pressure conditions in advance of the barometer, the use of simple instruments of this type in situations where maps of weather conditions to windward are not available, might lead, especially in the latitudes of the prevailing westerly winds and cyclonic storms, to valuable results.

B. M. VARNEY

HARVARD UNIVERSITY

A SIMPLE AND EFFICIENT LECTURE GALVANOMETER ARRANGEMENT

IN view of the extensive use to which the lecture galvanometer is nowadays put in physical and other laboratories, I have been induced to describe a particularly simple arrangement which has been thoroughly tested and whose performance leaves little to be desired.

In this arrangement a firm tripod, supported by a convenient shelf on one wall of the lecture room, carries a 90° arc lamp clamped by a right-angle piece to its vertical rod. The lamp is mounted with the positive carbon vertical, and its luminous tip, the source of light, uppermost. On a wall bracket a converging lens with its axis vertical is mounted about a meter above the arc. The galvanometer, a D'Arsonval instrument with plane mirror, is mounted on a wall shelf with its mirror, *A*, about 0.4 meter above the lens and about 0.1 meter nearer the wall. A second and larger plane mirror, *B*, is mounted with universal adjustments at the edge of the galvanometer shelf. It is fixed vertically above the lens in a horizontal plane a little below *A*. A scale with 2-inch divisions is mounted horizontally near the top of the wall opposite the galvanometer about 9.5 meters away. The galvanometer terminals are permanently connected with binding posts on the lecture table.

When the optical adjustments have been made, light from the tip of the positive carbon, converged by the lens, falls upon the mirror *B* and then upon the mirror *A*, which reflects it to the scale. At the center of the scale a round and brilliant image of the luminous carbon tip is formed. Focal adjustments can be made by moving the lens vertically on its bracket, or the lamp vertically on its rod; and the position of the image on

the scale can be adjusted with ease and precision by moving the tripod on its shelf. With the lens used in my apparatus, which is 8 cm. in diameter, the range of the latter adjustment is very great.

The galvanometer mirror used here is $\frac{5}{8}$ inch in diameter. The lamp can be operated with either direct or alternating current, and the image is so bright that it has never been necessary to darken the room. The inexpensive lamp of the type used here is provided with a metallic hood, and with a pin hole and mica screen for adjusting the arc, which is controlled by hand. As used in this arrangement the edge of the hood is horizontal. While the round image of the carbon tip is sharp enough for all ordinary purposes, readings being taken to tenths of scale divisions, yet if it is desired to make one edge of the image straight and perfectly steady, this can be done simply by laying a bar of metal on the hood and moving it partly over the carbon until the adjustment is correct. By using a larger mirror on the galvanometer a more brilliant image could of course be obtained.

The arrangement described above has been in use here for over a year. During the preceding three years an automatic lamp with vertical carbons and an extra mirror were used instead of the hand regulated 90° lamp. The second arrangement has proved to be more satisfactory than the first. An automatic 90° lamp would of course be still more satisfactory.

S. J. BARNETT
THE TULANE UNIVERSITY OF LOUISIANA

THE AMPHIBIA OF THE MAZON CREEK SHALES

THERE have been but two species of Amphibia recognized from the shales which are exposed along Mazon Creek, Illinois. These two species are the remarkable reptile-like microsaurian *Amphibamus grandiceps* described in 1865 by Professor Cope and the salamander-like branchiosaurian described the past year by the writer under the name *Micrerpeton caudatum*. It is thus with considerable interest that the writer is able to announce the discovery of seven additional species distributed in six additional genera. This new and considerable addition to the knowledge of the Mazon Creek fauna is made possible through the courtesy of Drs. Schuchert and Eaton, of Yale University, who very kindly placed at the writer's disposal the entire collection of Mazon Creek Amphibia belonging to that institution.

The material is represented by ten specimens, including the most perfect example of *Amphibamus grandiceps* so far seen. This specimen makes possible the verification of the author's restoration of that form and the addition of the ischia. The other specimens are undescribed and represent a diverse fauna. An additional species of the family Amphibamidæ is represented by a well-preserved anterior half of a skeleton. Three additional branchiosaurian species are preserved. One of these species, represented by two specimens, is most remarkable for the preservation of the entire alimentary canal and a portion of the oviducts in both specimens. This on comparison with living Amphibia proves to show close resemblances to the alimentary canal of an immature branchiate individual of *Diemyctylus torosus* Eschscholtz from a freshwater pond on Orcas Island in Puget Sound. The other two species are remarkably like *Branchiosaurus* of Saxony, but differ in having an extremely elongate tail.

Perhaps the most interesting discovery in this new material is that of a primitive embolomerous amphibian of the order Temnospondylia. It is related to *Cricotus* and may be placed in the family Cricotidæ. It differs from *Cricotus*, however, in the form of the centrum and the relatively greater length of the component elements. The notochordal canal is widely open. A sixth species is founded on a fore limb which shows relationships to the family Molgophidæ, which has, so far, been known only from the Coal Measures of Linton, Ohio.

Our knowledge of the amphibian fauna of the Pennsylvanian up to the present time would indicate that the forms had already developed into local groups which had few connecting types. We may regard the new

member of the Molgophidæ as one of these connecting types. This localized specialization means that we must look into the Mississippian and the Devonian for the earliest of the Amphibia in North America, as the foot prints which have been discovered in these deposits would indicate.

The discovery of the new temnospondylous form with other facts of the distribution of the Temnospondylia indicates that the order originated in North America. At least the earliest known forms occur in this continent.

The amphibian fauna of Mazon Creek at the present time may be regarded as represented by nine species which are members of four orders and five families. The orders are: Branchiosauria, Microsauria and Temnospondylia. An additional fact of interest is the discovery of osseous branchial arches in an imperfectly preserved specimen; the second species from the Pennsylvanian in which these structures have been seen. This means the presence of a fourth order of Amphibia in the Mazon Creek shales.

ROY L. MOODIE

THE UNIVERSITY OF KANSAS,
January 14, 1910

A FIXING FLUID FOR PLANT TISSUES

MY experience with Bouin's fluid as a fixing material for certain plant tissues for cytological work has been so satisfactory that I take this opportunity of recommending it to plant cytologists as one which combines a number of admirable features. It has, of course, been used for a number of years in connection with animal tissues, and especially for studies of spermatogenesis, in which it gives notably clear preparations. I first tried it, along with a number of other solutions, for fixing anthers of *Œnothera*, in 1908. The formula used was as follows:

	Parts
Picric acid, saturated aqueous solution ..	75
Glacial acetic acid	5
Formaline	20

Of course, various modifications of this may be found advantageous for different plant forms.

The time of fixation must be short, otherwise maceration results. It should probably not exceed four to six hours. The time of washing must also be comparatively brief, as long washing causes deterioration and fragmentation of the material. *Œnothera* anthers, after a few hours' immersion in this fluid, frequently acquire a slight pinkish tint, which remains indefinitely after the material has been dehydrated and placed in 70 per cent. alcohol.

This solution seems to be a favorite one for studies on animal spermatogenesis, and I see no reason why it should not become popular also for various purposes in plant cytology. Its obvious advantages are (1) that, unlike osmic solutions, it leaves the tissues clear and transparent, (2) its penetration seems to be very rapid, giving an even and almost perfect fixation of the material, (3) it leaves the cytoplasm and nuclei perfectly colorless, giving particularly clear and brilliant results in staining chromatin and spindles when followed by Heidenhain's iron-hæmatoxylin stain.

R. R. GATES

MISSOURI BOTANICAL GARDEN

THE AMERICAN SOCIETY OF NATURALISTS

THE American Society of Naturalists met at the Harvard Medical School, Boston, Mass., on Wednesday, December 29, 1909. There were both morning and afternoon sessions. The program consisted of original papers and demonstrations of studies on evolution, and the meeting proved to be one of the most successful in the history of the society. The variety and importance of the papers read are well shown by the following list of titles:

PAPERS

U. Dahlgren: "Origin of the Electric Tissues in Teleost Fishes" (lantern).

D. T. MacDougal: "Origination of Parasitism in Higher Plants."

F. Boas: "The Influence of Heredity and of the Environment on Man."

E. Brainard: "The Evolution of New Forms in *Viola* through Hybridism."

R. R. Gates: "The Material Basis of Mendelian Phenomena" (lantern).

A. M. Lutz: "The Relation of Chromosome-

Number to Vegetative Characters in the Œnothera" (lantern).

G. H. Shull: "The Inheritance of Sex in *Lychnis*."

F. E. Lutz: "Experiments concerning the Reversion of Domesticated Races to the Wild Type."

W. J. Spillman: "Mendelian Phenomena Independent of de Vriesian Hypotheses."

C. B. Davenport: "Some Consequences of Imperfect Dominance."

J. Reighard: "The Biological Meaning of Conspicuousness in Animals" (lantern).

T. H. Montgomery: "Secondary Sexual Characters in Spiders."

C. W. Beebe: "Racket Formation in the Tail Feathers of the Mot-Mot."

E. M. East: "A Mendelian Interpretation of Variation that is Apparently Continuous."

W. L. Tower: "Causes and Consequences of Variability in Alternative (Mendelian) Inheritance in Experiment and in Evolution" (lantern).

W. E. Castle: "On the Nature of Mendelian Factors."

A. F. Shull: "The Artificial Production of the Parthenogenetic and Sexual Phases in the Life Cycle of *Hydatina senta*" (read by Professor T. H. Morgan).

H. S. Jennings: "Experimental Evidence on the Effectiveness of Selection."

There were interesting discussions of some of the papers; but the program this year, unfortunately, proved to be too crowded to permit of the proper time allowance for this very desirable feature.

DEMONSTRATIONS

A new departure was the demonstration of specimens, etc. This list also surely indicates that the naturalists have selected a most promising field of interest to all biologists.

U. Dahlgren: Gross and microscopic preparations of electric tissues; also lantern slides.

D. T. MacDougal: Parasitism in plants.

R. R. Gates: Lantern slides.

A. M. Lutz: Paintings, lantern slides and microscopic preparations of Œnothera.

F. E. Lutz: Specimens.

W. J. Spillman: Specimens.

C. B. Davenport: Illustrations of inheritance of plumage color.

J. Reighard: Colored photographs and transparencies.

C. W. Beebe: Bird skins.

E. M. East: Specimens and lantern slides.

W. L. Tower: General demonstration arranged to illustrate phases of investigation now in progress. (1) photographs; (2) specimens showing results.

W. E. Castle: Specimens.

H. S. Jennings: Diverse genotypes in *Paramœcium*.

COOPERATION

The Botanical Society of America left most of Wednesday morning free to the Naturalists, and the American Society of Zoologists adjourned early in the day. Thus good audiences were possible. It seems probable that interest in the society will continue and grow, if the program is, in future, kept closely in touch with modern work of such general importance to all biologists. This was, after all, the essential principle of the society in its early years.

PUBLICATION OF PAPERS

The papers presented before the society will be published in *The American Naturalist*, in a series, as supplied by the authors.

The president's address, on "Chance or Purpose in the Evolution of Adaptations," was delivered at the dinner in the Hotel Somerset, on the evening of the same day. This address is published in the present number of SCIENCE.

NEW MEMBERS

The following new members were elected: F. N. Balch, Boston, Mass.; R. S. Breed, Allegheny College; R. Chambers, University of Toronto; H. Colton, University of Pennsylvania; W. W. Ford, Johns Hopkins Medical School; A. J. Goldfarb, New York; H. G. Kribs, University of Pennsylvania; A. Petrunkevitch, American Museum of Natural History; Q. J. Simpson, Palmer, Ill.; F. M. Surface, University of Maine; C. B. Thompson, Wellesley College.

The officers elected for the year 1910 are:

President—Dr. D. T. MacDougal, Carnegie Institution.

Vice-President and chairman of the Eastern Section—Dr. H. S. Jennings, Johns Hopkins University.

Treasurer—Dr. E. M. East, Bussey Institution, Boston, Mass.

Secretary—Dr. C. R. Stockard, Cornell University Medical School.

Members of Executive Council—Dr. Raymond Pearl, University of Maine, and Dr. F. Boas, Columbia University.

H. McE. KNOWER,
Secretary for 1909

THE AMERICAN SOCIETY FOR PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS

This society, which was organized at Baltimore, December, 1908, held its first annual meeting in Boston during convocation week. The object of the society is to promote pharmacology and experimental therapeutics and to "facilitate personal intercourse between investigators who are actively engaged in research in these fields." The membership is now fifty-two.

At the business meeting on December 29 a constitution was adopted and the following officers elected:

President—J. J. Abel.

Secretary—Reid Hunt.

Treasurer—A. S. Loevenhart.

Additional Members of the Council—A. C. Crawford and G. B. Wallace.

Membership Committee—C. W. Edmunds, S. J. Meltzer and Torald Sollmann.

On December 30 a scientific session was held at which the following demonstrations and papers were presented and discussed:

DEMONSTRATIONS

D. R. Joseph and S. J. Meltzer: The mutual antagonism between magnesium and barium.

J. Auer (with P. Lewis): Demonstration of anaphylactic immobilization of the lungs in guinea-pigs.

W. H. Schultz: A simple respiration apparatus.

S. J. Meltzer: A demonstration of the method of respiration by continuous intratracheal insufflation.

PAPERS

Central Vasomotor Effects: T. Sollmann (with J. D. Pilcher).

An organ is left in connection with the vasomotor center, but separated from the circulation, and perfused artificially. Cardiac effects, and direct actions on the vessels, are thus excluded, thereby permitting the study of the activity of the vasomotor center. The response of this center to physiological and pharmacological conditions is under investigation; a number of the results were reported.

Studies upon the Action of Certain Salts on the Isolated Intestines: M. V. Tyrode.

Strips of rabbit's small and large intestines kept alive in the author's nutritive medium and tested by different methods showed an increased motor activity when magnesium sulphate, sodium sulphate and sodium phosphate were applied internally but decreased activity when these salts were applied externally, particularly well marked after magnesium sulphate.

On the Behavior of Certain Arsenical (and other) Compounds in the Treatment of Experimental Nagana: J. J. Abel (with L. G. Rowntree and E. A. Slegle).

The authors have met with success in the treatment of experimental nagana in using certain arsenical and antimony compounds, whose method of preparation together with results obtained will be described in detail in the near future.

The Effect of Certain Drugs upon the Toxicity of Acetphenetidin and Paramidophenol: W. Hale.

A control series of mice were fed plain cakes or upon cakes to which a single drug had been added, and the time until their death was noted. In a second series cakes were fed which contained a mixture of two of the above drugs. In this way it was shown that the toxicity of acetphenetidin (phenacetin) and para-amidophenol was increased in mixtures with small amounts of caffein, sodium bicarbonate and codeine.

On the Pharmacological Action and Antiseptic Value of Certain Benzoic Acid Derivatives: A. S. Loevenhart (with A. Arkin).

The following products were studied:

(1) Sodium ortho-iodbenzoate, $C_6H_4\left<\begin{matrix}I\\COONa\end{matrix}\right.$

(2) Sodium ortho-iodosobenzoate, $C_6H_4\left<\begin{matrix}I{=}O\\COONa\end{matrix}\right.$

(3) Sodium ortho-iodoxybenzoate, $C_6H_4\left<\begin{matrix}I\left<\begin{matrix}O\\O\end{matrix}\right.\\COONa\end{matrix}\right.$

The first has very little antiseptic action, while the second and third are antiseptics of considerable strength for the organisms studied. Evidence was presented to show that the germicidal properties of these substances is dependent upon the active oxygen combined with the iodine. The presence of protein did not diminish the antiseptic action of these substances. Work is under way to establish their therapeutic value.

The Effects of Urea and Hypertonic Solutions on the Circulation: J. A. E. Eyster. (Read by title.)

Urea causes an increase in the size of contraction of the frog's and terrapin's heart. Hypertonic solutions of sodium chloride and glucose exert a similar effect, but the effect with urea

occurs also in isotonic solution. Isotonic solutions of urea cause a slight constriction of the blood vessels of the frog, hypertonic solutions of urea and sodium chloride a dilation. Hypertonic solutions of urea, sodium chloride and glucose injected intravenously in cats and rabbits cause an increase in cardiac output and a vasodilatation of the intestinal and renal vessels.

The Biological and Chemical Assay of Ergot: H. C. WOOD, JR.

The method used for determining the activity of ergot physiologically was based on the rise of blood pressure, the average rise for ten minutes after the injection being taken as the physiological figures. Comparative tests having shown that the amount of benzol soluble matter in the fluidextract of ergot bears a close relation to the physiological activity of the specimen, a method of chemical assay based on this fact was suggested. The body obtained by extracting the fluidextract with benzole yields a nitrogenous body on prolonged shaking with dilute acids, which is highly active.

Inhibition of the Pancreas: C. W. EDMUNDS.

The pancreatic secretion produced by secretin is inhibited by the vaso-constricting action of adrenalin, nicotine, pituitary extract and strychnine. When these drugs do not cause vaso-constriction they do not inhibit the pancreas. After the injection of adrenalin the pancreas may not regain the normal volume for five minutes and with pituitary extract it may be eight minutes, which facts explain why the inhibition persists after the blood-pressure has returned to the normal height.

If the high blood-pressure produced by adrenalin is lowered by secretin to the normal height, or below, the inhibiting action of adrenalin is not removed because the lowering of the blood-pressure is due to weakening of the heart and not to vasodilation.

Barium chloride may inhibit or accelerate the pancreatic flow depending upon whether it constricts the pancreatic vessels or dilates them and thus increases the blood supply to the organ.

When the pancreas is stimulated by pilocarpine its activity is inhibited not only by adrenalin but also by fresh injections of pilocarpine provided the blood supply of the organ is lessened in amount by the slowing of the heart produced by the pilocarpine.

Strophanthin Absorption from the Gastro-intestinal Tract: R. A. HATCHER.

Strophanthin is not absorbed from the alimentary canal of the rat, and the absorption is extremely irregular in the cat and the dog, and apparently so in man.

Further Studies on the Influence of Alcohol on the Composition of Urine: W. SALANT (with C. H. HINKLE).

3 to 4 c.c. of ethyl alcohol, diluted to 50 per cent., fed to dogs by mouth caused diminished excretion of total nitrogen, phosphates, chlorides, total sulphur, total and inorganic sulphates. Conjugated sulphates and neutral sulphur were, on the contrary, increased.

The Toxicity of Caffein: W. SALANT (with J. B. RIEGER).

Resistance to caffein varies in different species of animals. Rabbits and guinea-pigs can stand much larger doses than cats, dogs or pigeons. The toxic dose of caffein by mouth in the rabbit is much greater than that given subcutaneously. Toxicity of caffein is greater when injected into the muscles, still greater when given intravenously. Chronic intoxication with caffein was induced by the administration of doses insufficient to induce acute symptoms and caused emaciation and loss of strength. Starvation diminished the resistance to caffein.

Tolerance for Caffein: W. SALANT (with J. B. RIEGER).

By the subcutaneous administration of gradually increasing doses at intervals of two to five days, cats survived quantities of caffein which were 60 to 70 per cent. greater than the fatal dose. Rabbits and dogs similarly treated stood smaller doses.

On the Use of Phenolsulphonephthalein in Estimating the Function of the Kidneys: L. G. ROWNTREE and J. T. GERAGHTY.

Phenolsulphonephthalein administered subcutaneously is excreted quantitatively in the urine; in health over 90 per cent. of a 3 to 12 mg. dose being recovered in two hours as estimated by the Duboscq colorimeter. In disease of one or both kidneys, the degree to which the function is impaired can be estimated by a decrease in the amount of drug excreted. The drug is non-toxic, non-irritant, and first appears inside of ten minutes and these small doses are entirely excreted in from two to two and a half hours.

On Insufflation of the Lungs with Hydrogen, Carbon Dioxide and Air: C. C. GUTHRIE. (Read by title.)

REID HUNT,
Secretary

SOCIETIES AND ACADEMIES

THE BIOLOGICAL SOCIETY OF WASHINGTON

The 464th meeting of the society was held January 8, 1910, in the west hall of George Washington University, with President T. S. Palmer in the chair and a large attendance of members. Vernon Bailey exhibited a skull and beak of the water turkey (*Anhinga anhinga*), calling attention to the peculiar adaptation of the barblets on the sides of the beak.

The following communications were presented:

The Muskrat Industry of Maryland: D. E. Lantz.

The muskrat, because of its abundance and the adaptability of its fur to a variety of uses, has lately become the most important fur animal of North America. The tide-water region of Maryland, Delaware and New Jersey furnishes a large percentage of the entire catch of this fur, which last year amounted to five and a half million skins, bringing nearly $1,700,000 to the trappers of America. Last March the speaker visited Dorchester County on the eastern shore of Maryland and studied the methods by which trappers and marsh owners carry on the muskrat industry there.

The marshes of that region are usually leased to trappers for half the catch of fur. Measured by the returns of last year, the marshes are worth nearly as much as ordinary agricultural lands adjoining them. About 250,000 skins were taken in the county. These and the muskrat meat sold brought into Dorchester County an income of over $100,000, or more than was netted from the vast oyster industry of the county.

Muskrat meat is common on the tables of the inhabitants of that region, and the surplus is shipped to Baltimore, Wilmington and other cities, where it commands a ready sale and is eaten by all classes.

The eastern shore is noted for the large proportion of black, or melanistic, muskrats, the pelts of which command a higher price than those of the common color. Some of the Dorchester County marshes yield fully half of this variety.

The importance of wise laws for the protection of muskrats in sections where it is not destructive to dams and embankments was pointed out and the common practise of trapping this animal before its pelt is prime was condemned. The protective law for Dorchester County limits trapping to the period from January 1 to March 15, experience having shown that with this restriction the supply of this fur is reasonably constant from year to year. The animals breed three or four times during a season, producing from three to twelve young at a litter.

From Nairobi to Washington with a Collection of Living Animals: A. B. Baker.

While the Smithsonian African Expedition was at Nairobi, Mr. W. N. McMillan offered to the National Zoological Park through Lieutenant Colonel E. A. Mearns, chief of the expedition, a small collection of wild animals which he had at his ranch, "Juja Farm," about 25 miles from Nairobi. These animals, which included five lions, a leopard, two cheetahs, a warthog and several other animals and birds, had been in captivity for some time, most of them having been caught when very young. The offer was referred to Washington and an acceptance of the gift was cabled back at once.

Mr. Baker sailed from New York on July 24 and after stopping at London and Hamburg to arrange for transportation, and visiting some of the European zoological gardens, reached Mombasa, September 16 and Nairobi two days later.

In addition to the McMillan animals several antelopes, a zebra and a few other animals were secured by purchase and as gifts. Shipping boxes were made at Nairobi, much of the material used for them having been sent out with the outfit of the Smithsonian party.

Much difficulty was experienced in obtaining suitable forage, as it was not in the market at Mombasa, and a two-years' drought about Nairobi had made forage extremely scarce there. A supply was finally obtained from farther up the country, where the rains had been less scanty. The animals were shipped from Nairobi October 26, and after some delay, owing to a washout on the railway, they left Mombasa, October 28, by the steamer *Melbourne*, of the Compagnie des Messageries Maritimes.

Reaching Port Said on the night of November 8, the animals were kept on a lighter there until the twenty-first, one of the conditions imposed by the U. S. Department of Agriculture in granting the permit for entry being that the animals should not be landed at any place en route, unless it might be in England. Through the kindness of Captain S. S. Flower, director of the Giza Zoological Gardens, near Cairo, the assistance of a trained animal keeper was had during the stay at Port Said. The animals were forwarded from there by a German freight steamer, and reached Philadelphia, December 17. Favorable weather was experienced throughout the journey. A pair of gnus, and an impala died during the first four

days of the journey. They had been caught only a few days before shipping. Two young bottle-fed gazelles and a lophiomys also died, and one eland (a gift) which was very thin and weak at the start. Both of the McMillan cheetahs died before the shipment was made. The other animals arrived in excellent condition and were as follows: five lions, a leopard, Ælian's warthog, Grant's zebra, pair Livingstone's eland, pair Coke's hartebeest, female waterbuck, Thomson's gazelle, baboon (species not yet determined), lophiomys, crested eagle, Bateleur eagle, two vultures and a hawk.

The ruminants and warthog were subject to fifteen days quarantine, and Mr. A. E. Brown, director of the Philadelphia Zoological Garden, kindly received them there for that period. The others were brought to Washington at once, and reached the park December 19. All of the animals have done well thus far, except the male eland, which died suddenly at the Philadelphia garden. The autopsy did not show any condition which would account for the death. Rabbits have been inoculated with the blood of the quarantined animals, and the animals will be kept at Philadelphia until the results of this are known.

The collection includes fifteen species, of which eleven are new to the park.

The Present Status of the Bark Disease of the Chestnut: HAVEN METCALF. (Illustrated with lantern slides.)

A disastrous chestnut disease was first reported in 1904, in the vicinity of New York city, and in 1906 was stated by Murrill to be caused by a new fungus, which he named *Diaporthe parasitica*. It is probable that this disease had existed for a number of years previously about New York and on Long Island. At the present time it has spread from Saratoga County, N. Y., and Suffolk County, Mass., on the north and east, to Bedford County, Va., on the south, and Greenbriar and Preston counties, W. Va. and Westmoreland County, Pa., on the west. The fungus attacks the tree at any point above the ground, producing cankers of the bark, which spread until they meet in the bark on the opposite side, thus girdling the trunk or limb upon which they are situated, thus death may result very quickly by girdling. Sprouts are regularly formed below girdled points, and are quite characteristic of this disease. Roots and first-year wood are rarely, if ever, attacked. The most common places for the occurrence of cankers are the large crotches, the base of the trunk and the ultimate twigs. Progress of the disease is most rapid during the spring months; but south of New York, at least, inoculations may take effect at any time of the year. A debilitated tree is no more subject to attack than a healthy one. So far as known, all species and varieties of the genus *Castanea* are subject to the disease, except the Japanese chestnut which is almost completely immune. It has so far been found impossible to produce the disease in any related genera. The fungus ordinarily gains entrance through wounds, of which the commonest are the tunnels produced by various bark borers. Such wounds as these are always moist, and hence favorable to the growth of any spore. Lesions resulting from winter injury afford entrance to the fungus, but winter injury bears no other relation to the disease. The presence of the characteristic fungus forms a certain basis for distinguishing whether any given case is the bark disease or winter injury alone, but recourse must be had, even by the expert, to the damp-chamber and the compound microscope, since in dry weather the fungus may produce no spores. The bark disease shows no definite relation to the points of the compass, as the location of lesions is determined by the position of the wounds through which the fungus gained entrance. In small, smooth-barked trees, death may be prevented by a system of inspection and cutting out of diseased tissue, somewhat similar to that practised with pear-blight. On large, thick-barked trees this is impracticable, as it is impossible to distinguish disease lesions under the thick bark. It is impossible to prognosticate what the disease will or will not do in the future, as there are very few historical data from which to judge the course of this or any other plant disease. The dry summers of the past two years have slightly checked the progress of the disease, but it remains to be seen what a damp summer may do.

D. E. LANTZ,
Recording Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT the 440th regular meeting, January 18, 1910, Dr. C. Hart Merriam addressed the society on "Myths of California Indians." The speaker confined himself to the three great groups of central California. Their myths, though they are obviously not homogenous, have the same personages and characters, viz., the pre-Indian inhabitants

who disappeared at the advent of the Indians and the coyote man. The myths quoted referred to the acquisition of fire.

In the discussion Drs. Fewkes, Swanton and Hewitt quoted parallels from the Casa Grande, the Northern Pacific and the Iroquois, respectively.

Dr. Walter Hough followed with a paper on "Incense and Incense Burners." The use of incense in America for religious ceremonies has never been very thoroughly studied. The paper treated in a general way of the diffusion of the materials employed and especially of the apparatus in which incense is burned. The discussion was therefore confined largely to the apparatus found among the cultured tribes of Central America, Mexico and the southwest United States. In the latter area occur forms which are possibly connected with those in Mexico. The paper also discussed the pipe as an incensario.

In the discussion Dr. Casanowicz dwelt on the use of incense, in domestic and social life as well as in the cult and magic, among the ancient nations and quoted passages which hint at a dæmonifuge background of its use. Mr. Hewitt pointed out that among the Iroquois incense is sometimes employed to emphasize a petition. Dr. Fewkes referred to the fact that among the Hopi Indians all ceremonies opened and closed with a smoke. Its object is to obtain rain; the smoke is to make a cloud, and the rain-god seeing the cloud would send rain.

I. M. Casanowicz,
Secretary

National Museum

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

The ninety-sixth regular meeting of the section was held on January 21, 1910, at the Twentieth Century Club, Boston.

A motion was passed in favor of holding alternated bi-monthly meetings jointly with the New England Section of the Society of Chemical Industry.

Professor Louis Derr, of the Massachusetts Institute of Technology, presented a paper entitled "Color Photography at the Present Time." After a brief statement of the underlying principles of color photography, the speaker pointed out the advantages of the process depending upon the use of finely ruled screens, and showed why it had failed commercially. He then described the French single plate process involving the use of dyed starch grains, and he showed how some of the very recent English single plates were prepared and used. The lecture was profusely illustrated with very beautiful and striking examples of color photography, including some most remarkable results with brilliant micro-photographs.

There were about one hundred members and guests present.

K. L. Mark,
Secretary

RHODE ISLAND SECTION

The regular meeting of the section was held January 20, 1910, at the University Club, preceded by the usual informal dinner.

The paper for the evening was given by Dr. John E. Bucher, of Brown University, on the subject "The Structure of Retene and its Relation to some Natural Resins." The presentation of Dr. Bucher's work, which was illustrated by charts, showed conclusively that the correct structure of retene is 8-methyl-2-isopropylphenanthrene and not the formula ordinarily published in the literature.

Several new and valuable methods of oxidation were developed during the work, notably the use of pyridine as a solvent for the potassium permanganate oxidation of substances insoluble in water; and also, oxidation by nitric acid in the presence of manganese nitrate as a catalytic agent.

As a continuation of the work the relation of retene to common rosin and abietic acid is now being studied.

The paper will soon be published in the *Journal of the American Chemical Society*.

Albert W. Claflin,
Secretary

Providence, R. I.

CLEVELAND SECTION

The third regular meeting of the session of 1909–10 was held in the Main Building of Case School of Applied Science, December 13.

The following papers were presented: Charles F. Brush, "The Commercial Manufacture of Oxygen from the Atmosphere"; F. R. Van Horn, "The Brick Industry of Cleveland."

This meeting marked the end of the first year of the existence of the Cleveland Section and was certainly the most interesting and successful meeting since the section was organized.

N. A. Dubois,
Secretary

SCIENCE

FRIDAY, FEBRUARY 18, 1910

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

PRINCIPLES OF PALEOGEOGRAPHY[1]

INTRODUCTION

THE science of the geography of past geologic periods, which is sometimes known as paleogeography, is a young science that has all its future before it. It springs from several older sciences: geography, geology, meteorology and paleontology; and in its development it must rest upon their general principles.

Paleogeography may be defined as the science of geography of all periods of the globe's history since earth, air, and water assumed those states in which they now exist. The science does not extend to any earlier state of the world. But from the time of the earliest lands, seas, and atmosphere to the present, the sequence of geographic conditions comprises the facts of paleography.

The science is very comprehensive. It includes not only the arrangement of continents and oceans and their individual features, but also the topography of lands, the circulation of oceanic waters and of the atmosphere, the climate, and the distribution of life, which were characteristic of the earth's surface during any particular epoch. It must trace the changes in these features from epoch to epoch, and with the aid of all allied physical and biological sciences, paleogeography should search out the ultimate causes which actuate the de-

[1] Address of the vice-president and chairman of Section E—Geology and Geography. American Association for the Advancement of Science, Boston, December 28, 1909.

velopment of the earth's superficial forms and of the earth's inhabitants.

The science of geography, as it is commonly understood, relates to a single geographic condition, that of the present. There have been many others in the past.

The present geographic condition or geography is peculiarly distinguished by large continents and high mountains, by extremes of polar cold; by great humidity of some regions and excessive aridity of others, and by corresponding diversities of faunas and floras. The geography of Quaternary time has been and is abnormally developed.

The geographies of the past have been individual also; sometimes, though rarely, they have exhibited extreme characters, equal in diversity of conditions to the Quaternary period; but as a rule extremes have been less pronounced and a nearer approach to simplicity of features has prevailed.

Could we at any past time have viewed the earth from without with an all-seeing eye, during any one epoch, we should have seen a single geography, a panorama. If we might have maintained our vigil from age to age during all her history as the globe, we would have observed the succession of geographies, a long procession.

In that procession we would have seen moving forward the great lines of evolution in the animate and inanimate world.

Slowly rising in response to the working of internal terrestrial forces, continents have emerged from the waters. Wasted by erosion they have in part been submerged again. Again they have risen and again sunk. The rhythm of their movement, the grand rhythm of the sphere, is timed to millions of years.

In comparison transient as the passing seasons of the year, mountain chains have grown under temporary though titanic stresses of the crust, and have wasted under the rays of the sun and drops of rain. Generation after generation of ranges has appeared, paused, and passed; incidents of the geographic procession, but integral features of it, obeying in time and place the law of its progress.

Atmosphere and ocean, those fluent envelopes of the sphere, have to outward appearance been least changeable, but they also have changed. Their currents circling westward against the revolving sphere and returning eastward, have adjusted their courses to the seas and lands. Subtly too the air and waters have been modified chemically as the critical constituents of the air and the soluble salts in the waters ran their changes in the laboratory of land and sea.

All of the changes suggested are linked in a chain of cause and effect, from continental movements to atmospheric circulation. Finally the evolution of living organisms is conditioned by them all. The life impulse, tending to develop new forms, has been helped or hindered by environment. Favored by congenial and widening habitats, faunas have diversified, become enriched, have spread, and attained cosmopolitan range. Or restricted to narrowing uncongenial districts, they have lost by extinction of the unadaptable elements and become limited to the surviving fittest. Had environment been unchanging, evolution would have run its course chiefly according to the intrinsic influence of the life-principle, but since environment has ever been changing, adaptation to modified external influences has played a dominant rôle.

The great procession of geographies, which has moved down the ages, has obeyed those laws of inorganic and organic change, which we recognize as the principles of

geography, geology, oceanography, climatology, paleontology and evolution. The principles of astronomy, physics, chemistry and biology are also involved to the extent that they enter into the development of geographic conditions.

Because paleogeography is thus comprehensive, no one investigator can adequately solve its problems. A group of students only can do the science justice. In attempting this statement of its general principles, I do not fail to recognize the fact that it must be incomplete and qualified by inadequate understanding of many of the branches of knowledge involved.

PERMANENCE OF OCEAN BASINS

Oceanography is a science which as yet scarcely ventures over the threshold of the present upon the long vista of the past, but the guidance of paleogeography leads that way. From the study of ancient lands and epicontinental seas we are led directly to the recognition of ancient ocean basins; it is, however, particularly among European geologists, still a mooted question whether the hollows, which the waters occupy, have constantly existed as hollows or may have been sites of continents which have now sunken in. The evidence that the hollows have constantly existed is strong. Upon it rests an assumption, which must be either affirmed or denied, there being no third condition, and which may be stated in the affirmative form as a principle:

The great ocean basins are permanent features of the earth's surface and they have existed, where they now are, with moderate changes of outline, since the waters first gathered.

This conclusion rests upon three principal facts:

The continents have never been submerged to oceanic depths and consequently can not have been replaced by deep hollows.

The oceanic basins have always been of such capacity that they contained by far the larger part of the waters, which have overflowed on the continents only as relatively shallow epicontinental seas; hence no considerable part of the existing basins can ever have been occupied by land.

There is a relation between the intensity of gravity and the relative altitude of a continental or oceanic plateau, which proves that the plateaus have assumed different altitudes according to the densities of the subjacent material. The transformation of a continent into an ocean basin, or *vice versa,* would require, therefore, a change in density of an enormous volume of material, and there is neither evidence nor explanation of such a change.

A few words may be said in support of these propositions, but before doing so a distinction should be made between the great ocean basins and those deep troughs which have from time to time developed within continental plateaus and which Dana called geosynclines.

In their genesis ocean basins and geosynclines may have been similar; but in their dimensions, histories and structural relations they are radically different.

I will not dwell on the great magnitude of the Atlantic or Pacific basins in comparison with the Appalachian or Cordilleran geosynclines. They need but be named.

The history of a geosyncline comprises a prolonged stage of subsidence accompanied by more or less constant deposit of terrigenous or marine sediment, and often a further stage of compression, folding of strata and elevation as a mountain range.

The history of ocean basins does not exhibit a similar stage of subsidence within the eras of the geologic record, although the hollows have sometimes apparently

deepened enough to affect the extent of epicontinental seas. And no ocean basin has been compressed, crumpled and raised, after the manner of the Appalachians or Alps.

The structural relations of geosynclines are intra-continental, those of oceans are extra-continental. The geosyncline occupies a position among the positive continental elements. The oceanic basins separate and surround continents.

The distinction between geosynclines and ocean basins is thus fundamental, and to reason from the history of the one to that of the other, as has sometimes been done, is necessarily misleading.

This distinction noted, we may return to the proposition that the ocean basins have always been permanent since ocean waters gathered.

The evidence is clear and unquestioned that marine waters have circulated and marine faunas have migrated from epicontinental seas of the eastern or western hemisphere to those of the other hemisphere, and they could only have done so across or around bodies of water occupying the sites of the present oceans.

We have good reason to assume that the volume of oceanic waters has not changed materially from what it was at the inception of existing conditions, it being apparently true that contributions from within the earth have been relatively small during geographic eras, and none being known from without.

The ocean basins are now somewhat overfull; they are not large enough to hold all the waters, which therefore extend over the margins of the continents. During certain epochs of the past the waters have spread farther, the basins having then been less capacious; again during certain other epochs the waters have withdrawn into deeper or wider basins. These variations have lain within narrow limits as compared with the total volume of the oceans, and they have occurred repeatedly, in alternation. Had a continent ever existed in place of one of the ocean basins, it must on sinking to oceanic depths have produced a disturbance of these nicely adjusted relations, of which the geologic record shows no trace; which must, however, have been of such magnitude that it would have marked off an older era of small lands from a later one of great continents. No such event has taken place, and no continent of oceanic extent has sunk to oceanic depths.

This conclusion bears on the reconstruction of former continental extensions. If we accept the evidence that Appalachia formerly extended southeastward into the Atlantic, we must consider reasonable limits. If we erect a transatlantic land to connect Africa and South America, or postulate a Gondwana land from Africa to Australia, we must provide for the waters which such lands displace. The ocean basins and possible epicontinental seas are the only refuge for the waters which are thus hypothetically evicted, and their capacity may be overtaxed.

The capacity of a basin being affected by changes in depth or width, it is obviously possible to argue that narrower but deeper basins may formerly have contained the waters that are now held in wider and possibly shallower ones. To a certain extent this view may be entertained, but it has limits and they are close to present conditions. The average depth of nearly two thirds of the ocean's basins below the continental plateaus is 4,000 meters or more. At this difference of altitude the weight of the continental column crushes its base and creep ensues. The depth can not be materially increased without occasioning corresponding spreading and low-

ering of the continental plateau, till the present condition of approximate isostatic balance were reached.

The postulate of isostatic equilibrium among masses of unlike densities in the earth's crust has recently been strongly supported by the work of Putnam[2] and Gilbert[3] on gravity in the United States, of Hayford[4] on the deflection of the plumb line in the United States and of Hecker[5] on the attraction of gravity on the oceans.

Hecker puts the general conclusion thus:

> It follows that not only the superficial masses of the continents must be compensated by a defect of mass, a less density in the earth's crust under the continents, but also that there is compensation beneath the deep seas through the greater density of the ocean bottom.
>
> Inasmuch as it has been shown that Pratt's [Dutton's] hypothesis of the isostatic relations of masses holds not only for the continents, but also for the three oceans (Atlantic, Pacific and Indian), we may regard it as a law which, apart from certain disturbances, is a general one for the earth's crust.

This conclusion appears to place the permanence of ocean basins outside the category of debatable questions.

A conclusion which follows closely from that of the permanence of oceans, is the *constancy of the major oceanic drifts or currents from an early date in each of the great oceans.*

Movements of ocean waters result from winds and differences of density of the waters. The trade-winds and their complements, the westerly winds of higher latitudes, are due to causes which have existed since the atmosphere and oceans formed; to rotation of the earth and to the distribution of the sun's heat. These causes operating through the winds on water bodies of oceanic dimensions must have always produced an east-to-west equatorial current, which being diverted by continents, developed great circulatory movements in the several ocean basins, flowing clockwise in the northern hemisphere and anti-clockwise in the southern. On the basis of the arguments just presented, the ocean basins are permanent, and hence the great superficial oceanic currents which characterize them must be regarded as equally ancient in their main features.

This conclusion regarding superficial currents does not necessarily apply to the deeper circulation, and there are reasons for believing that the latter is now abnormal. The deep-seated circulation is occasioned by differences of density or head, dependent upon temperature, salinity, precipitation and heaping of the waters by wind. Chamberlin[6] has suggested the analysis of these factors and has brought out the possibility of a change in the equilibrium of the waters, which may have resulted in *warm highly saline currents flowing poleward from the equator, beneath cool relatively less saline currents flowing toward the equator;* the reverse of the present condition.

The density of polar waters is attributed primarily to cold, and, as Chamberlin points out, may be increased in those regions where ice forms and where there are no large rivers by the salts forced out of

[2] Putnam, G. R., "Results of a Transcontinental Series of Gravity Measurements," *Phil. Soc. Wash. Bull.*, Vol. XIII., pp. 31–60, 1895.

[3] Gilbert, G. K., "Notes on Gravity Determinations by Mr. Putnam," *ibid.*, pp. 61–76, 1895.

[4] Hayford, J. R., "The Figure of the Earth and Isostasy," U. S. Coast and Geodetic Survey, 1909.

[5] Hecker, O., "Die Schweresbestimmung an der Erdoberflache und ihre Bedeutung für die Ermittelung der Massenverteilung in der Erdkruste," *Zeitschr. der Gesell. für Erdkunde*, Berlin, No. 6, 1909.

[6] Chamberlin, T. C., "On a Possible Reversal of Deep-sea Circulation and its Influence on Geologic Climates," *Jour. of Geology*, Chicago, Vol. 14, 1906, p. 363.

the superficial layers in freezing. Were the more profound causes of the climatic state so modified as to ameliorate the severity of polar cold, both of these influences would be moderated, and the effects of freshening by rivers and precipitation would not be offset to the extent that they now are.

On the other hand, equatorial waters are warmed and evaporated, and they are thus rendered light because warm, yet heavy because saline. The actual density, as compared with that of polar waters, is now less than the latter, but both observation in the oceans and calculation show that the balance is small. Were the polar waters less chilled or more freshened or both, the equatorial waters would be heavier, and the reversed circulation suggested by Chamberlin must result.

The cold of the present polar climates is extreme and unusual. To whatever fundamental causes we may attribute it, we know that it did not exist during the Miocene, Eocene, Cretaceous, later Jurassic, Carboniferous, Devonian, Silurian, Ordovician, or later Cambrian. Frigid conditions may have occurred with severity in the earlier Jurassic or Triassic and in the early Cambrian or late pre-Cambrian. That is to say at periods which, like the present, were periods of exceptional continental expansion and elevation. It seems to follow cogently that the condition of oceanic circulation which depends upon polar cold is also exceptional. Under more genial conditions, the waters in high latitudes would be lighter than now because warmer. They would also be more generally freshened by precipitation, and nowhere rendered more saline by freezing. The conditions which now occasion the greater density of polar waters would thus fail and the balance would sink on the side of the equatorial waters. Heavier equatorial, lighter polar waters have probably been the normal condition; the reverse, which now exists, the abnormal.

This conclusion follows entirely apart from the consideration that the extraordinarily mild climates of some ages are rendered less difficult to understand if the deep-seated circulation of the ocean were thus reversed, if it had normally been a movement of warm waters in the depths, instead of at the surface, toward the pole. But the facts, which it explains, strengthen the hypothesis and place it in the front rank of important suggestions in the study of paleogeography.

PERIODICITY OF DIASTROPHISM

Diastrophism, the process which comprises all movements of the earth's crust that modify continents or give rise to mountain ranges, has been characterized by periods of activity in alternation with periods of quiescence, throughout all geologic history.

This principle of the periodicity of earth movements rests upon the observation that periods when continents emerged from the sea and became mountainous have alternated with periods when continents had become low and were extensively submerged.

The emergence of continents and the growth of mountains are due to activity of the internal terrestrial forces; the reduction by erosion to low lands and the resubmergence mark the period of inactivity. The Quaternary is a time of decided activity, resulting in large continents and great mountain chains. It has been preceded by times of relative quiescence and by others of greater movement, in alternation, as far back in the past as the record goes.

While geologists in general will agree that this is a true principle, they find it

more difficult to define the respective periods.

It is possible to recognize at least three grand cycles from late pre-Cambrian time to the close of the Mesozoic, each grand cycle consisting of a long period of activity and a still longer time of relative quiet, thus:

Late pre-Cambrian activity (apparently somewhat general), Cambrian and Ordovician inactivity (general),	nth cycle.
Silurian and Devonian activity (qualified by circumpolar quiet in the north), Late Devonian and early Carboniferous inactivity (general),	$(n+1)$ cycle.
Later Carboniferous and early Mesozoic activity (non-contemporaneous in different dynamic provinces), Later Mesozoic and early Tertiary inactivity (general),	$(n+2)$ cycle.

Later Tertiary and Quaternary then constitute the initial, active period of the $(n+3)$ cycle.

While these grand cycles may be recognized for the whole world as far as we know the facts, it is found that each one may be divided into epicycles consisting of shorter periods of emergence and submergence *especially if attention be fixed upon a single ocean basin and the continents adjacent to it.* The North Atlantic, for instance, is bounded on the east and west by lands, which have been disturbed or have been at rest during the same epochs, and the several cycles have been of much shorter duration than those enumerated above for the whole world. These cycles are indeed those on which the time-scale of geologic history is based, and each one corresponds in general with a standard period, Carboniferous, for example.

Lands about the Arctic Ocean did not share in the Atlantic movements of Silurian, Devonian or late Paleozoic epochs. On the contrary, the great epicontinental seas of those periods were circumpolar. Nor do lands about the North Pacific, from California to China, record a history parallel with that of eastern North America and northwestern Europe, with the Atlantic history. In the Atlantic provinces, the Paleozoic era closed with marked diastrophism, while comparative tranquillity reigned around the Pacific; but the Pacific provinces were greatly disturbed in the middle Mesozoic when quiet had supervened about the Atlantic. Again, a distinct series of movements is recorded in the great geosyncline of Eurasia, that which stretches from India to Spain and is now marked by the system of mountain chains of which the Himalaya and the Pyrenees are the extremities. Similar movements appear to characterize the West Indies and northern South America. If, as I believe, these parallel movements in Eurasia, South America and the Indies originated in a common dynamic region, then that region is the great ocean of the southern hemisphere, including the South Atlantic, the South Pacific and the Indian oceans.

The principle of periodicity is necessarily qualified by these facts and the general law should be supplemented by one which recognizes unlike dynamic histories of different oceanic regions. It may be stated thus:

The phenomena of diastrophism are grouped according to several distinct dynamic regions. Each region has experienced an individual history of diastrophism, in which the law of periodicity is expressed in cycles of movement and quiescence peculiar to the region. The cycles of one region have been, however, to some extent parallel, though not conterminous, with the cycles of other regions, and thus major cycles of world-wide condi-

tions are constituted by coincidence of regional conditions.

The periodicity of diastrophism is the fundamental fact of geographic history. It carries with it corresponding periodic effects, both direct and indirect, in erosion, sedimentation, climatic changes, and even in organic evolution. All of these processes depend upon the initiative action of the earth's internal energy and they all are rhythmic because its action is rhythmic. Thus this general principle gives rise to correlative principles, which may be stated independently for each of the processes.

PERIODICITY OF EROSION AND SEDIMENTATION

American geologists need no restatement of the phenomena of cycles of deposition and erosion which Newberry[7] emphasized and which have led through the work of Powell, Gilbert and Davis to recognition of the principle that epochs of marked relief and vigorous erosion have alternated with periods of base-leveling, and that sediments have alternated correspondingly in character and volume. I may pass the subject of base-level periods and orogenic epochs as related to erosion and sedimentation with this reference to it, mentioning only that it is the essential principle in Chamberlin's[8] latest contribution to the philosophy of correlation; but though the principle is accepted there is still occasion to dwell upon *the constancy of erosion and the inconstancy of sedimentation*, especially since the facts may be the reverse of what is sometimes assumed and since they lie at the foundation of our interpretations of the geographic record.

[7] Newberry, J. S., "Circles of Deposition," Amer. Assoc. Adv. Sci., *Proceedings*, Vol. 22, pt. 2, 1874, pp. 185–196.

[8] Chamberlin, T. C., "Diastrophism as the Ultimate Basis of Correlation," *Jour. of Geol.*, Chicago, Vol. 17, 1909, pp. 685–693.

It is assumed in some instances that erosion on supposed subaerial surfaces has either not occurred or has left no traces, whereas on the other hand the surfaces, if they had been submarine, must invariably have been covered with sediment, which would constitute a record. And the conclusion is drawn that sections which exhibit an incomplete sequence of strata must have been land areas at certain times. It is a hazardous conclusion in the absence of definite evidence of erosion, for subaerial processes never fail to leave some kind of mark, and submarine processes are consistent with non-deposition.

Constancy of Erosion.—The atmosphere is never at rest. Wind, rain and snow; heat and cold; moisture, carbonic acid and other chemical agents; all these have ever worked unceasingly, according to the circumstances that condition them, upon exposed land surfaces. No land has ever been exempt from their attack, which results in decay, denudation or aggradation, as the case may be.

Decay, denudation and aggradation are processes of erosion which invariably leave chemical or mechanical evidences of their activity. There is to-day no surface of any land, however high or low, under any climate whatever, which does not bear indubitable marks of one or the other of these processes. There is abundant evidence that they have been at least equally active and effective during past ages and that they have marked ancient lands as they do those of to-day.

We frequently recognize ancient land surfaces on evidence of soils, wear or subaerial deposits. Or, if they have passed through processes, such as marine transgression, that destroy the earlier effects, we observe the sequence of changes and reason back to the corresponding conditions. But there are seemingly continuous sections

which are nevertheless apparently less complete than others in adjacent basins and which seem therefore to have been areas of non-deposition. Even if the hiatus be real, and not merely supposititious, it does not follow that non-deposition has been a subaerial condition. Such anomalies of non-deposition occur characteristically between strata laid down during periods of wide-spread marine transgression when lands were low and covered with residual or alluvial deposits. If any area was raised higher during the interval, it must have been correspondingly corraded. And if the evidences of decay or corrosion are wanting the postulate of a land area corresponding to the region of non-deposition should be regarded with much doubt.

Inconstancy of Marine Sedimentation.—It is commonly assumed that sediment of some sort necessarily accumulates over the bottom of a marine basin and that this has always been the case in epicontinental seas of all ages. Consequently non-deposition is not considered and special hypotheses of uplift and subaerial erosion are devised to account for the absence of strata which might or should have been deposited. Yet non-deposition and even the scouring of bottoms so that hard rock is exposed are conditions of modern sea bottoms where they are swept by currents whose load is less than their efficiency.

Verrill has described the coarse shifting sands of the New England coast, which are kept in such constant motion by tidal currents that no life finds lodgment on them. The whole continental platform from Long Island to Hatteras is so swept that sand alone comes to rest, all finer sediment being carried on to the zone of oceanic ooze.

Agassiz found hard limestone bared of any deposit except serpularia and similar clinging organisms beneath the silt-laden Gulf Stream, where it flows across the epicontinental platform, between Florida and Cuba. Among existing seas and straits this instance is one which, in the conditions for marine scour, most nearly resembles the epicontinental seas of past times.

Between Scotland and the Faroe Islands stretches the Faroe Island ridge, a wide stony bar between the North Atlantic and the Arctic basins. Its crest lies 300 fathoms below the surface of the ocean; yet it is swept clean, while banks of ooze accumulate on the slopes north and south of it.

The present distribution of lands and oceans is unfavorable to marine scour and favorable to deposition. Epicontinental seas are confined to the margins of continental platforms, to which high lands contribute abundant sediment, or they are deeply embayed and shut off, as Hudson Bay is. Non-deposition is therefore an exceptional condition. We may grant that it has always been restricted to comparatively shallow waters, in the path of a relatively strong marine current. But the epicontinental seas of the periods of great marine transgressions (Cambrian, Ordovician, Silurian, Devonian, Mississippian and Cretaceous of North America for instance) opened channels across the continent, through which oceanic currents circulated as the Gulf Stream flows from the Caribbean to the Atlantic. Low lands bordered these seas and the deposits which accumulated in the deeper basins consisted in great part of fine calcareous ooze. Under these conditions non-deposition and marine scour have been favored on shallows along shores and in straits, and in any such places a corresponding hiatus must occur in the stratigraphic sequence.

In paleogeographic study it is important, therefore, to consider the principle that marine waters may not only deposit sediment, but may also prevent deposition, or even remove a deposit previously made.

PRINCIPLES RELATING TO CLIMATE

The history of past climates affords problems which are among the most obscure of paleogeography.

On the one hand climate at any particular epoch has been determined by the distribution of land and sea and the corresponding movements of the winds and positions of the great cyclonic and anticyclonic centers. Given a map showing the oceans and lands of the northern or southern hemisphere, the climatologist may apply the principles deduced from the present relations of atmospheric activity to surfaces that affect the temperature of the atmosphere in different degrees and he may arrive at a reasonable conclusion in regard to the distribution of temperatures and precipitation.

Such a conclusion is based, however, upon existing climatic conditions and can be only a rough qualitative approximation to the very different conditions of earlier ages. The geologic record yields abundant evidence to show that our present climates are unusual in the extreme differentiation of climatic zones. No previous age offers evidence of equal polar refrigeration, and none has as yet shown proof of deserts of equal extent and general distribution. On the contrary, it would seem that climate in the past has been generally more uniform from pole to pole and around the earth than it is now.

We may attempt to explain this result of observation by recognizing that the present diversity of climates is connected with extreme conditions of mountain growth. Mountain ranges are to-day more general and of greater altitude than they have commonly been in the past and the condition of the low lands, which has at times prevailed over the greater part of the continent, has been favorable to uniformity just as the converse is favorable to diversity of climate. But this explanation falls far short of satisfying the requirements of the problem.

We may supplement the reasoning by appeal to the reversal of oceanic circulation suggested by Chamberlin as a possibility in view of the fact that equatorial saline waters, even though warm, might under certain conditions become denser than fresher polar waters, even though these be cold, and thus warm waters sinking in the equatorial regions and flowing toward the pole would carry with them the higher temperatures of the tropics and produce more genial climates in the polar regions. This suggestion is extremely attractive, and has a high degree of probability, particularly when we consider that the present circulation of deep-lying cold waters is largely due to the polar ice-caps, which are themselves extraordinary features. There is reason to believe that the present oceanic circulation is abnormal and the reversed circulation suggested by Chamberlin has in past ages been the normal condition.

In recognizing the effectiveness of low lands and reversed ocean currents to produce uniformity of climate such as the geologic record requires, we arrive at a working hypothesis which satisfies the immediate condition of certain climates that characterized great periods of the earth's history; but we are yet far from an understanding of the processes which underlie the change from one condition of climates to another. There is some general cause, so subtle that it has as yet eluded distinct recognition, which affects the conditions of climate more deeply than the local phenomena suggest. It has been approached by theories along astronomical lines and by a single theory which connects climate with the earth's internal forces.

The astronomical causes may be shown

to have an essential relation to climate, but at present I believe we can not fairly say that that relation has been shown to have existed. On the other hand, there appears to be a definite connection between the physical geography of the earth's surface and the climate of any corresponding epoch. Large continents and high lands have been associated with diversity of climate; small continents or archipelagoes and low lands have been associated with uniformly genial climates. Moreover, the chemical reactions between rock masses exposed to weathering and the critical constituents of the atmosphere and the seas, such as carbonic acid and moisture, appear to establish a chain of phenomena, which involve temperature and humidity, and which affect the intensity of provincial climatic differences. In a broad and general sense we may refer to the periodicity of climatic change in the same way that we recognize periodicity of general diastrophism, and the cycles of the one appear to coincide with the cycles of the other. Chamberlin has recognized the relation and has endeavored to trace it through the critical influence of the small percentage of carbonic acid in the atmosphere. In following the course of that critical element from the air through the laboratory of the lands and seas back to the atmosphere, he established a chain of phenomena which is unquestionably a *vera causa* of the common periodicity of the phenomena.

We may conclude then that the study of ancient climates involves two connected problems. The first relates to the distribution of provincial climates according to the distribution of lands, seas and permanent oceans. It may be approached by applying the laws of modern meteorology to a preliminary solution. That solution must, however, be tested against the geologic and paleontologic evidence of the corresponding time, and must be qualified by conclusions based upon broader principles which involve the physics and chemistry of the atmosphere in its relations to land and sea. Through these the second problem, which involves the periodicity of climates, is to be approached.

EVOLUTION AND ENVIRONMENT

In the long chain of causes and effects initiated by terrestrial and solar energy, the development of life is the latest link. All that precedes life is characterized by change which moves in a series of cycles. Life, on the other hand, is characterized by change which has moved forward in progressive evolution. Upon this fundamental distinction we separate the inorganic from the organic and recognize the latter as pertaining to a higher phase of development.

Evolution is not, however, the only attribute which distinguishes life from the lifeless, for life is qualified by the further attribute of death. The individual, the species, the genus, the family and race, everything which lives, ultimately comes to the final end, and there is in the evolution of the organic no return of that which has thus died. While the inorganic world repeats, the organic world never does.

Profound as these distinctions are, they nevertheless do not emancipate the organic from the control of the inorganic. Life is inexorably conditioned by its environment. Through ages of evolution and adaptation, each individual is fitted to exist under a special set of circumstances which constitute his environment. Narrow limits are set to the capacity of the organism to adjust itself to sudden changes, and only within those limits can it continue to exist. Beyond them on all hands stands the inevitable death. In the history of the individual there are special periods of

development, such as infancy, youth and old age, when these limits are narrower than they are for the epoch of full vigorous development of the adult; and these sensitive periods are those which are critical for the history of the species.

The influences which govern evolution have recently been stated by two of our great biologists, Jordan and Osborn. They both recognize that in the development of organic life the grip of environment holds.

Jordan,[9] dwelling on the importance of isolation as a factor in evolution, recently wrote:

Among the factors everywhere and inevitably connected with the course of descent of any species, variation, heredity, selection and isolation must appear; the first two innate, part of the definition of organic life, the last two extrinsic, arising from the necessities of environment, and *not one* of these can find leverage without the presence of each of the others.

Osborn has put the same principle as follows:[10]

The life and evolution of organisms continuously center around the processes which we term *heredity, ontogeny, environment* and *selection;* these have been inseparable and interacting from the beginning; a change introduced or initiated through any one of these factors causes a change in all. First, that while inseparable from all the others each process may in certain conditions become an initiative or leading factor; second, that in complex organisms, one factor may at the same time be initiative to another group of characters, the inseparable action bringing about a continuously harmonious result.

These modern statements of the law of natural selection find application immediately as we contemplate the procession of geographies. Change of environment is inherent in the movement of the procession down the ages and, cooperating with intrinsic biotic forces, has caused modification of organisms as a necessary consequence.

Environment as related to any species or to any flora or fauna may be said to be that combination of conditions to which the fauna is adapted and beyond which it can not range into other environments. From this follows the principle: ***Except through renewed adaptation, an adapted fauna can migrate only as the limits of its habitat recede, as the area of its environment broadens.***

To apply this principle to the distribution and migration of species or groups of species under the general law of periodicity, we may follow the course of a cycle of changes, from an epoch of diverse conditions through a cosmopolitan state to diversity again.

Diverse conditions of any one geographic state may have been grouped simultaneously to form many environments or faunal provinces, and each of these has then been occupied by its peculiar fauna contemporaneously with more or less unlike faunas in other provinces. Each of these faunas represented an adaptation to the conditions of its peculiar environment. The peculiarities of other faunal provinces surrounding it constituted barriers beyond which the species could not live, or could not rear their young, even if the adults could exist under the adverse conditions. Only within those barriers could those specially adapted species long continue to exist. If their habitat became contracted they also must contract their range; if it shifted or expanded, they might migrate accordingly. And there would be corresponding migration or restriction of faunas which were diversely adapted. Any cause which shifted the conditions of light, heat or food, brought opportunity to some, death to others.

[9] Jordan, David Starr, Isolation as a Factor in Organic Evolution, in "Fifty Years of Darwinism," 1909, pp. 90–91.

[10] Osborn, Henry Fairfield, Darwin and Paleontology, in "Fifty Years of Darwinism," 1909, pp. 238–239.

In the circling changes of geography such an epoch of diversity has been followed by the development of more or less extensive uniformity, according to the periodicity of diastrophism. Let it be assumed that in the course of a long period of quiet, barriers yielded to the monotony of low lands, freely communicating seas, and genial cosmopolitan climates. The factors of evolution were then profoundly generalized. Isolation was replaced by intercourse, adaptation by competitive development and variation, restriction by opportunity. Success lay with him who had the intrinsic capacity to occupy and to hold the widening realm of life. Out of such conditions came cosmopolitan faunas, which exhibit closely similar or identical associations of species even though inhabiting widely separated regions. The identity may be due to *perpetuation of ancestral species,* which have followed up the movement of a favoring habitat; or it may result from evolution of a successful fauna, competent to spread throughout the wide kingdom to which it is born. In the one case the migrants may have lived simultaneously with descendants of the common ancestors in the home province, or the ancestral stock may have died out there before the migration was complete. *The time equivalent or coefficient of migration is indeterminate.* In the second case, that of *indigenous evolution,* the time elapsed while the species spread over an area which was everywhere geographically favorable depended only upon the ability of the migrant and may be assumed to have been brief as compared with geologic epochs. This is the usual assumption. It may be true for appropriate species and periods, but is by no means always true.

Cosmopolitan conditions have been truly world-wide only in exceptional cases. Very extended faunal provinces have been less rarely developed. The Arctic Ocean has been one which repeatedly expanded to include much of Eurasia and America. The girdle of ocean currents which encircled the world in the northern, temperate and tropical zones during Paleozoic, Mesozoic and Eocene times was another such province. Both of these became from time to time the homes of cosmopolitan faunas that existed simultaneously over surprisingly wide realms. At other times they were restricted or divided and faunas became provincial.

If we consider the course of evolution during an epoch when general conditions yielded to provincial environments (excluding the case in which the change is too drastic) the law which applies is Jordan's law of isolation. He uses that term to signify the separation of one or many individuals from others of their kind. The separation implies more or less diversity of environment and consequently more or less unequal or unlike variation along the many possible paths open to the living organism. We conceive a broad life realm, marine or terrestrial, which through subtle changes in the flow of currents of the sea, or of climates of the land, or of depth of waters, or of altitudes above the seas, or of any other condition affecting sensitive organisms, is divided into provinces which offer unlike environments to the descendants of the ancestral cosmopolitan fauna. Adaptation becomes again the dominant process. Being variously conditioned, it leads to variation and the development of different species.

North America represents the facts upon which Jordan[11] founded the law of twin species, which is that:

[11] Jordan, David Starr, Isolation as a Factor in Organic Evolution, in "Fifty Years of Darwinism," 1909, p. 73.

Given any species (or kind) in any region, the nearest related species (or kind) is not to be found in the same region, nor in a remote region, but in a neighboring district separated from the first by a barrier of some sort.

This law, worked out by observation of existing faunas and based on their distribution in our highly diversified lands, owes its recognition to the fact that topography and climate have undergone great changes, and provincial environments have been individualized during the latest geologic periods.

The latest period to which we can assign fairly uniform conditions of climate and moderate relief in North America is the Miocene, and the diversity of environments developed since then is so great that there is reason for surprise at the persistence of geminate species. One might expect differentiation to a degree which would have obscured or obliterated twinship. But it appears that there are provinces in which variations of some ancestral species have not diverged greatly, presumably because conditions within these particular provinces have not undergone any very stimulating or very restrictive change, as regards those species. Such surviving varieties must indeed have existed to a greater or less extent during any such period of changing environments, and the persistence of geminate species must have been a feature of many epochs of diastrophic activity in the past. How long they may have persisted, how slowly or rapidly or impulsively they may have varied, we do not know. *The time relations of geminate species are therefore indeterminate.*

CORRELATION

Definition.—By correlation in paleogeography or geology, I understand that process of reasoning which seeks to demonstrate that certain events of past history occurred simultaneously.

Contemporaneity.—In dealing with the enormous time intervals of the earth's history the concept of simultaneous or contemporary events must be liberally grasped. A fair statement is that the phenomena described as contemporaneous shall have existed at the same time within limits of error which do not equal a large fraction of the life of either. Thus we call two men contemporaries when the periods of their active lives coincide, though one may have been born notably later and live longer than the other. But we do not so term a youth and a graybeard, whose living occupies but a few years in common.

It is evident that two long-lived events may differ from near coincidence in time by a larger margin than two short-lived events, and yet be reasonably regarded as contemporaneous. The marine transgression which submerged most of North America during the Cambrian was in a broad sense contemporaneously paralleled by submergence of much of Eurasia; but the moment of arrival of the earliest Cambrian fauna, the Olenellus, which followed the spreading shores over each continent, can not be regarded as contemporaneous at points reached earlier and later in course of the submergence.

The evidences of contemporaneity are both inorganic and organic, but, though we are wont to classify them thus in two distinct categories, they are most intimately related through that principle of periodicity, which is at the bottom of all terrestrial phenomena. Diastrophism is periodic, all changes in the inorganic as in the organic are conditioned by that periodicity, and all such changes are therefore themselves periodic. Moreover, the physical and biological phenomena are linked in a continuous chain of cause and effect, which stretches from gravity and internal heat at one end to life at the other, and which

tends ever to vibrate in harmony. Whatever disturbs the equilibrium of any part, affects the whole. Diastrophism initiates change. The sun's energy modifies the resulting surface features, and physical, chemical and biotic reactions carry the effects into all the phenomena of nature. Were nature unchanging, time would pass unrecorded. It is through the sequence of unlike *effects* that we may establish a chronology, and that sequence begins with diastrophism as the initial cause and ends with evolution as the final effect.

DIASTROPHISM THE BASIS OF CORRELATION

It follows logically from the preceding that the initial cause of change, diastrophism, is necessarily the ultimate basis of all correlation. Chamberlin[12] has very recently put this conclusion strongly and clearly.

On a preceding page the law of periodicity of diastrophism is stated as deduced from the observed occurrences of diastrophic movements in different dynamic provinces. According to that law it is *inactivity, rather than activity,* of earth movements, which has contemporaneously characterized the whole earth. That is to say, the normal condition of the stresses and resistances in the earth's crust is a close approach to equilibrium, and disturbances of that equilibrium have in general been manifested at the surface by slight movements only. More emphatic movements have been relatively occasional and provincial (circum-oceanic), and we may add that they have been more restricted and less prolonged as they have been more vigorous.

This law governs the relation of diastrophism to correlation.

The long eras of inactivity, the base-level eras for the whole world, have been essentially contemporaneous, though not conterminous or even approximately conterminous. But their very great duration, from which their essential contemporaneity results, unfits these eras for any except the broadest outline of classification, so far as they themselves are concerned. Yet the topographic, climatic and environmental uniformity which developed during these eras of inactivity affords the best conditions for correlation by other criteria. Thus the base-level eras are to the history of paleogeography what the broad and deep foundations of a great building are to the many rooms of the superstructure.

Thus for inactivity. The periods of activity present different phenomena, differently distributed in place and time. We may define a period of activity as comprising that time which is marked initially by decided continental movements and culminates in notable orogenic uplifts. Pennsylvanian and Permian constituted such a period about the North Atlantic, as witness the development of lands, mountains and sediments in western Europe and eastern North America. The recognized active periods appear to characterize distinct dynamic provinces which are ocean basins, as already described. Thus with regard to their value in correlation we may say: *Periods of active diastrophic movement have been shorter than eras of base-leveling, and consequently define time divisions, which are more nearly commensurate with those of current geologic standards.* They are, however, still long, and their value is in broad fundamental classification.

Diastrophic activity is, moreover, contemporaneously manifested only in and around the dynamic province in which it originates. During any particular period it has been peculiar to a particular oceanic basin or group of basins and has disturbed

[12] Chamberlin, T. C., "Diastrophism the Ultimate Basis of Correlation," *Jour. of Geol.*

only the continental masses adjacent to that basin or basins. The value of periodic activity in correlation is thus conditioned by the regional distribution of diastrophism.

Continents bordering on one and the same dynamic province have usually been disturbed during one and the same period. Opposite sides of one and the same continent, however, bordering on different dynamic provinces, do not exhibit similar conditions of disturbance at the same time.

Western Europe and eastern North America, for instance, exhibit parallel diastrophic histories, peculiar to the North Atlantic basin, but the diastrophic histories of the Atlantic and Pacific sides of North America do not run parallel.

Any great period of diastrophic activity, though relatively short as compared with an era of inactivity, is very long in comparison with any particular movement incidental to its own development. Thus Pennsylvanian and Permian diastrophism had a long history before the folding of strata occurred in the Appalachian trough. Such an incident of folding, or of any orogenic growth whatever, is locally conditioned. It results from local structures and localized pressures. The time of disturbance depends upon the local position of the district in relation to the source of disturbing stresses, and is peculiar to the district. The phenomena of folding, or of orogenic growth, therefore, do not afford criteria for correlation beyond the area of special conditions. We may not safely correlate the displacement of the Appalachian zone with the disturbance of the Carboniferous in England, for instance, although both events occurred during the same diastrophic period and belong to one and the same dynamic province.

Within any *orogenic district*, the epoch of general disturbance is a principal element of classification. It is set apart, it is unavoidable. It must be recognized, and it commonly separates major divisions.

This stated, it is none the less of the first importance to insist on the local character of the criteria. A district of orogenic disturbance is sharply limited by mechanical conditions. Across the line exist other conditions, which are inconsistent with orogeny and its manifestations. The criteria of correlation by orogeny fail, therefore, beyond the line. Disturbance and quiet, erosion and continuous deposition, unconformity and conformity, have developed simultaneously in immediately adjacent districts many times.

In strong contrast to continental and orogenic movements, which develop subaerially, are those subsidences which occur beneath the oceans. Though they also are more or less local, their effects are practically world-wide, for any submarine movement modifies the capacity of ocean basins and changes the position of sea level on all coasts. No other phenomenon is so nearly simultaneous.

If any one of the confluent ocean basins be deepened the sea level datum about all lands must be lowered. The effect may not be evident in the exceptional case that any land subsides by a due amount; but the exceptional case is not likely to mask the general effect of a universal ebb tide. Shallowed and reduced epicontinental seas, low islands and low coastal plains mantled with the latest sediments, slight erosion and unconformity without disturbance of the strata, constituting a general condition of continents, these are the characteristic phenomena of such an ebb. They distinguish the middle Ordovician of regions as remote as eastern North America, eastern China and western Europe. They mark also the passage from Cretaceous to Eocene.

Suboceanic movements have no doubt

occurred, especially during periods of pronounced continental deformation, but also during eras of quiescence on lands. Their effect upon sea level is, however, readily confused or masked by local uplift or depression and is, therefore, of little value when these become decided. During base-level eras the conditions for recognition are most favorable and the occasional occurrence of a world-wide ebb constitutes the most exact measure of contemporaneity by which we may correlate.

The several groups of diastrophic phenomena which have been outlined furnish the fundamental basis of classification and correlation. They are obviously very unequal in scope, character and value. Their geographic range may embrace the sphere, or fall within the realm of an ocean, or be no more extensive than a mountain district. Their duration may equal a vast era, or merely a period, an epoch or even only an episode. But all other phenomena are dependent and sequential. Diastrophism sets the stage and marks off the acts of the earth drama.

ORGANIC CRITERIA OF CORRELATION

I turn now to those criteria of correlation which are most universally employed, the criteria of organic evolution.

All paleontologists and geologists who are familiar with the geologic side of their science, as distinguished from the biologic, are convinced of the influence of environment on evolution; and they consequently recognize the dependence of species in regard to origin, development and distribution, upon the geographic conditions of their period of existence.

These extrinsic conditions have been by no means uniform from place to place or from time to time; they have varied periodically, and their influence upon life has differed in kind and degree according to the period. As has been emphasized by Chamberlin, marine life has at certain times been favorably conditioned by admission to broadening epicontinental seas, and alternately unfavorably conditioned by limitation to narrowed habitats on the margins of continental shelves. With similar effects terrestrial life has ranged over wide and connected continents under genial climates or has been confined to provinces of sub-continental or even smaller dimensions.

Marine life, when favored by extended domain, has also enjoyed genial and largely uniform environment. Shallow, freely communicating waters, traversed by continuous far-circling currents, offered uniformity. Barriers, whether of lands, or temperature, or sediment, or salinity, did not persist in marked degree at such times. Pressing against the shifting boundaries of his ancestral habitat, the marine migrant could advance as the limits receded, *no faster,* and thus a species fitted to compete in the occupation of new territory could spread from the provincial to the cosmopolitan with the corresponding spread of that environment to which it was adapted.

Assuming that the species persists during this time with only such variation as might be consistent with identification, the distribution will correspond to the spread of environment. The obvious fact is the presence of the species, or of the fauna, of one locality in another place also. The inconspicuous, but all-important fact is the control by the geographic factor, which has in any particular case determined a shorter or longer interval of migration. The migrants were descendants, who wandered as they could. That they could wander farther than their ancestors was due to a spreading sea, to the sweep of a marine current across a vanishing isthmus

or shallow, to a chilling or warming or other physical change, often as fatal to one fauna as it was favoring to another. The controlling factor was geographic; it set the hour of immigration; and through knowledge of it alone can we estimate the time elapsed during the wandering.

The case stated is that of passage from diversified to unified environments. It has repeatedly characterized geologic periods; and it has repeatedly culminated in the evolution and distribution of cosmopolitan faunas, which simultaneously peopled remote realms with like species. The coefficient of uncertainty, with which we must qualify any correlation that depends solely on identity of species, is reduced to a minimum at the time of culmination of uniformity.

Uniformity has in turn repeatedly yielded to diversity. Large marine faunal realms have been divided into provinces by emergence of continents, by diversion of ocean currents, by differentiation of climates, by local dilution or concentration of ocean waters and by the other changes which establish physical barriers. Lands have been diversified in like manner. In each such province evolution re-began by extinction of the unadapted and survival of the fitter forms. Originating in a common ancestry, the faunas of two neighboring provinces may for a time have had much in common. As they developed differences, Jordan's law of geographic isolation came into play. The resulting geminate species may have been closely contemporaneous; but continued contemporaneity depends upon uniform rates of differentiation, which the changing environments do not favor. Several relations, other than uniformity, are conceivable; isolate a fauna under static conditions and contrast it with the same fauna under changing conditions. Assume the changes to be favorable or unfavorable to the indigenous fauna. Contrast isolation with more or less free emigration and immigration. Consider the many factors of environment and the many possibilities of variation in sensitive, highly developed organisms.

Must we not conclude that diversity of species rather than likeness will be the rule at such a time among contemporaneous faunas?

But it is upon likenesses that we rest our faunal correlations. What do they signify? Simply that the surviving species of a fauna have remained unchanged during a longer or a shorter period, either at home or during migration, or that variations have developed similarly in two provinces from an ancestral stock similarly conditioned.

When we find a German fauna in New York or a Russian fauna in western North America, the occurrence means that the particular fauna persisted in an environment which offered it no stimulus to variation during the period of migration from the ancestral home to the new domain. But that period remains indeterminate. It was the shifting of the habitat that made the migration possible and that set the rate of progress. It was a geographic movement first and the faunal journey was a consequence.

Or in case of similar variations from an ancestral stock, can we assume that the stimuli acted in different provinces at the same times and at the same rates? When they did, but only when they did, were the similar variations contemporaneous; and the cases of such coincidence may reasonably be regarded as exceptional.

Hence I conclude that:

Correlation by identical or closely related species, faunules or floras is subject to a coefficient of error, which is a function

of the geographic changes of the particular period and of the geographic conditions that preceded.

The coefficient may be placed at a minimum, which is possibly negligible, at times of established cosmopolitan relations; but it rises to a quantity which we can not neglect at intervening periods of physical change.

The emphasis here placed on the geographic factor in correlation should not obscure the initiative part played by the life principle. It is the evolutionary force; its energy and the direction of its action depend upon the kind of organism. But the conditions of its action, its rate and the result depend upon environment at any instant and upon environmental change in the long run.

SUMMARY

The broad general principles of paleogeography, which I would cite as most fundamental, are as follows:

1. Ocean basins are permanent hollows of the earth's surface and have occupied their present sites since an early date in the development of geographic features. This principle does not exclude notable changes in the positions of their margins, which on the whole have encroached upon continental areas.

2. Superficial oceanic circulation within the permanent oceans has persisted since an early stage of their existence, essentially in the great drifts which it now follows under the trade winds. It is probable that the present deep circulation of oceanic waters, poleward at the surface and equatorward below the surface, is due to exceptional refrigeration at the pole, and has been preceded during past ages by a prevailing reversed movement of warm saline waters from the equator in the depths and cool less saline waters from the poles on the surface.

3. Diastrophism has been periodic. Viewed according to the periodicity of diastrophism, the earth's history falls into cycles, and each cycle into two periods, one of inactivity and another of activity. The periods of inactivity have been long, and during a major part of the duration of any such period the condition of inactivity has been common to the entire surface of the globe. Inactivity has not been coterminous, however, in different regions.

The periods of diastrophic activity have been relatively short, and as regards the whole surface of the earth in general not contemporaneous. The great ocean basins are distinct dynamic provinces, and each has experienced periods of diastrophic activity peculiar to its individual history. Orogenic districts are sharply limited by local mechanical conditions. The epochs of organic deformation are relatively brief. And folding and unconformity, therefore, are frequently not contemporaneous even in one and the same dynamic province.

4. The processes of erosion, sedimentation, chemical activity and organic evolution have been periodically conditioned according to the periodicity of diastrophism. The corresponding physical phenomena (relief, deposits and climate) exhibit rhythmic changes which repeat similar conditions in like associations. Organic forms, both faunas and floras, evolving through intrinsic vital energy but not repeating, have been rhythmically conditioned by changing environments.

5. Erosion has been constant on land surfaces through the activity of some of the sub-processes, decay, denudation or aggradation, which have never failed to make a record. A fossil sub-aerial surface must always show the record, unless it has been obliterated.

6. Marine sedimentation has sometimes been inconstant. During periods of dias-

trophic activity, when lands have been high, epicontinental seas small, and marine currents largely confined within deep ocean basins, sedimentation has been dominant. But during periods of diastrophic inactivity, when lands have been low, epicontinental seas extensive, and marine currents active on shallows and straits, sedimentation has failed in consequence of non-deposition or marine scour in appropriate situations.

7. The criteria of correlation are both physical and organic. The physical facts are basal. The organic forms, though endowed with evolutionary energy, are dependent and sequential. Any ultimate classification of the earth's history must be founded upon all the phenomena, interpreted through their relations in the chain of cause and effect from diastrophism to life. BAILEY WILLIS

A NATIONAL BUREAU OF SEISMOLOGY

AT its last annual meeting, the American Philosophical Society showed its interest in the scientific investigation of earthquakes by devoting an entire session to their consideration. At the close of the session the following resolutions were unanimously adopted:

WHEREAS, Earthquakes have been the cause of great loss of life and property within the territory of the United States and its possessions, as well as in other countries, and

WHEREAS, It is only through the scientific investigation of the phenomena that there is hope of discovering the laws which govern them, so as to predict their occurrence and to reduce the danger to life and property, and

WHEREAS, Such investigations can be successfully conducted only with the support of the general government, be it, therefore,

Resolved, That this society urge upon congress the establishment of a national Bureau of Seismology, and suggest that this bureau be organized under the Smithsonian Institution with the active cooperation of the other scientific departments of the government and that this bureau be charged with the following duties:

a. The collection of seismological data.

b. The establishment of observing stations.

c. The organization of an expeditionary corps for the investigation of special earthquakes and volcanic eruptions in any part of the world.

d. The study and investigation of special earthquake regions within the national domain. And

Resolved, That copies of these resolutions be transmitted to the President, to the President of the Senate, to the Speaker of the House of Representatives and to the Secretary of the Smithsonian Institution.

Through the active interest of Dr. W. W. Keen, the president of the society, these resolutions were brought favorably to the attention of congress, and were in the House of Representatives referred to the Committee on Library, of which Honorable Samuel W. McCall, of Massachusetts, is chairman. The other members of the committee are E. L. Hamilton, of Michigan; Charles H. Burke, of South Dakota; William H. Howard, of Georgia, and Charles R. Thomas, of North Carolina.

Mr. McCall has already shown his appreciation of the importance of the subject, and it is hoped that readers of SCIENCE will lose no opportunity to urge upon their senators and representatives in congress the need of establishing such a bureau as is proposed, and to set forth the backward position of our government in this important matter as compared with foreign countries, though otherwise generously disposed towards scientific investigation.

There is already some danger that the matter may be disposed of through a small appropriation to some existing bureau, where the lack of special interest in the subject would soon result in the investigations being crowded out to make way for others which appeal more directly to the administration of the bureau. WM. H. HOBBS

UNIVERSITY OF MICHIGAN

SCIENTIFIC NOTES AND NEWS

THE national testimonial to Commander Robert Peary at the Metropolitan Opera House on February 8 was most enthusiastic, the house being completely filled. Governor

Hughes presided and a telegram was read from President Taft which expressed the hope that congress would take some substantial notice of Commander Peary's great achievement. Governor Hughes presented Commander Peary with a purse containing $10,000 which he immediately contributed toward fitting out an Antarctic expedition. A bill has been passed by the senate making Commander Peary a rear-admiral of the navy and placing him on the retired list.

THE Langley medal of the Smithsonian Institution, created in 1908 in commemoration of Professor Langley and his work in aerodromics, was presented to Messrs. Orville and Wilbur Wright on February 10. Dr. Alexander Graham Bell and Senator Lodge made addresses and Chief Justice Fuller presented the medals.

THE French Academy of Moral and Political Sciences has elected Professor William James, of Harvard University, a foreign member of the society, in the room of the late M. de Martens, of St. Petersburg. Professor James has been a corresponding member of the academy since 1898.

THE University of Cambridge has conferred the honorary degree of Sc.D. upon Dr. Mark Aurel Stein, explorer; and the honorary degree of M.A. upon the Rev. John Roscoe, missionary and anthropologist.

THE Academy of Natural Sciences of Philadelphia has appointed Professor Edwin Grant Conklin a vice-president, and Professor Ludwig von Graff, a corresponding member, as delegates to represent it at the eighth International Zoological Congress.

THE American Institute of Electrical Engineers has appointed Professor A. E. Kennelly president of the United States national committee of the International Electrotechnical Commission.

MR. CHAS. A. SCOTT, professor of forestry, Iowa State College, has been elected state forester for Kansas, under the provisions of a law enacted by the legislature of 1909. Previously he was for several years in the Forest Service of the United States Department of Agriculture.

DR. CHARLES B. DAVENPORT, director of the Station for Experimental Evolution of the Carnegie Institution, has given three lectures on "Heredity in its Application to Animal and Plant Breeding and to Man" at the Johns Hopkins University as follows:

February 7—"The Material Basis of Heredity."

February 8—"The Method of Inheritance of Characteristics."

February 9—"Heredity in Man."

THE students of Professor Spalding have set up a bronze tablet at the University of Michigan, bearing the following inscription:

VOLNEY MORGAN SPALDING

In commemoration of twenty-eight years of faithful service as teacher of botany in this university (1876 to 1904) and as a token of love and gratitude this tablet is erected by 100 of his former students.

Per naturæ opera mentem ad humanitatem fingebat atque virtutem.

Done in MCMIX.

The committee having the memorial in charge consisted of Professor L. R. Jones, Professor F. C. Newcombe and Dr. Erwin F. Smith.

DR. WILLIAM BRADLEY RISING, professor of chemistry in the University of California, died at his home in Berkeley on February 9 at the age of seventy years.

THE German Society of Scientific Men and Physicians will hold its eighty-second annual congress this year at Königsberg from September 18 to 24.

A CONVENTION of American Ceramic Societies was held in Pittsburgh on February 7, 8 and 9.

THROUGH DR. S. WEIR MITCHELL the College of Physicians and Surgeons of Philadelphia has received a gift of $75,000 from an unknown donor. The gift relieves the college from debt.

THE Tennessee Geological Survey will be established as a bureau of the state government, independent of any educational institution, with offices at the state capitol and with a director who will give his entire time to the work of the survey. Chancellor Jas. H. Kirkland, of Vanderbilt University, and President Brown Ayres, of the University of Tennessee,

are a committee of the board to select the state geologist and arrange other matters requisite for the inauguration of the survey. The annual appropriation is $15,000.

At a meeting of the board of managers of the National Geographic Society the following resolutions were adopted:

The National Geographic Society believes that it is of importance to science that tidal, magnetic and meteorological observations shall be obtained at or in the vicinity of Coats Land during the same period that the British expedition under Captain Robert F. Scott, R. N., is making similar observations on the other side of the Antarctic area, 1,800 miles distant, and at the same time that this recently discovered land shall be explored.

That the society is ready to accept Mr. Peary's proposition that it shall undertake jointly with the Peary Arctic Club an expedition to the Antarctic regions as outlined above, provided that the board of managers, after consultation with the members of the society, finds that the project will receive sufficient financial assistance to warrant the undertaking.

According to the daily papers, a delegation which included Dr. Ira Remsen, president of Johns Hopkins University; Brigadier General George H. Torney, surgeon general of the army; Dr. William H. Welch, president of the American Medical Association, and several others, have called on President Taft and urged the necessity for the cities of the country to adopt more scientific methods of sewage disposal. They asked the president to appoint a temporary commission to inquire into the matter. Mr. Taft said he was interested in the subject, but that he was without authority to appoint a commission.

During the summer of 1910 the University of Michigan Museum will be connected with three expeditions. As the depository of the state collections it will receive the specimens of the botanical investigations of a portion of the "peach belt" of Michigan, carried on by H. C. Kauffman and L. H. Pennington for the State Geological and Natural History Survey. Under a gift from Mr. Bryant Walker and an appropriation from the university the curator, Dr. Alexander G. Ruthven and Mr. H. B. Baker will make collections in southern Vera Cruz, Mexico, with the principal aim of enlarging the synoptic collection of molluscs and vertebrates. A third expedition financed by W. B. Mershon, Saginaw, Michigan, and to be known as the Mershon expedition will be sent to the Charity Islands, Saginaw Bay, Michigan, to continue the biological survey of the state that has been going forward for a number of years on appropriations from the state, university and private individuals.

UNIVERSITY AND EDUCATIONAL NEWS

Mr. Andrew Carnegie has promised to give to Cornell University the $50,000 required to enlarge Morse Hall, housing the department of chemistry.

The new biology building of the University of Wisconsin is to be placed on the upper campus, at the south end of the court of honor, between University and South Halls, facing the Lincoln statue. Originally plans were drawn to suit the site formerly chosen in the ravine between University and Observatory Hills. New plans appropriate to the new site will be prepared at once by the architects.

The New York *Evening Post* states that Mr. S. G. Iverson, state auditor, who recently made a thorough inspection of the school lands granted to Minnesota by congress in 1851, many years before the state government was organized, has compiled figures which show that the fund now amounts to more than $21,500,000, and that the state still holds approximately 3,000,000 acres of unsold land. These remaining lands have great wealth, fertile soil, abundance of growing timber, and the value of the iron ore deposits is almost beyond comprehension. "We have already 1,000 forty-acre tracts of land under mineral contracts in the iron-bearing districts," Mr. Iverson reports, "from which I believe we shall receive an average of 1,000,000 tons per forty, or a grand total of 1,000,000,000 tons, which, at a royalty of twenty-five cents a ton, the contract price, will produce the sum of $250,000,000. This endowment will be realized within fifty years, or before the state is a hundred years old. Of this sum I estimate that the school

fund will receive $170,000,000, the university fund $30,000,000, and the remainder will go to the swamp-land fund, the income from one half of which goes to the school fund and the remainder to assist in maintaining our state institutions."

A DEPARTMENT of experimental breeding has been established in the College of Agriculture of the University of Wisconsin by the regents, who have appointed Dr. Leon J. Cole, of the Sheffield Scientific School at Yale, an associate professor of experimental breeding. Dr. Cole will take up his new work with the opening of the second semester, conducting investigations in the subject of experimental breeding with special reference to the laws of heredity and improvement of animal life. He will also give instruction to advanced students. Dr. Cole graduated from the Michigan Agricultural College and the University of Michigan in 1901. He continued at Michigan as a graduate assistant for two years before entering Harvard University, where he obtained the degree of doctor of philosophy in 1906, and was appointed representative of the United States Bureau of Animal Industry in breeding work at the Rhode Island Agricultural College, whence he removed to Yale University in 1908.

THE Kansas State Agricultural College has established a new department, that of milling industry, and selected to head this department Mr. Leslie A. Fitz, now in the office of grain standardization, United States Department of Agriculture, and in charge of cooperative milling experiments and other work at the Fargo, N. D., Station. Mr. Fitz will enter upon his new field March 1. The object of the new department is to take cognizance more fully of the great importance of bringing to the market a more perfect grain and to investigate means of utilizing this to the greatest advantage. It will concern itself with all questions touching upon the wheat crop, flour making and bread baking. Mr. Fitz has been connected with the Department of Agriculture for several years and has been intimately associated with several lines of wheat investigation. He was also engaged in the same work previously at the Kansas State Agricultural College, of which institution he is a graduate.

E. K. SOPER, of Cornell University, has been appointed instructor in economic geology in the University of Minnesota.

MR. W. ASTON, M.A., demonstrator in physics, Birmingham University, has been appointed assistant to Sir J. J. Thomson in the Cavendish Laboratory, Cambridge. He is succeeded at Birmingham by Mr. E. E. Fournier d'Albe.

DISCUSSION AND CORRESPONDENCE

EARLIER REFERENCES TO THE RELATION OF FLIES TO DISEASE

IN the last number of SCIENCE (January 7) there is an interesting note by Dr. E. W. Gudger on Edward Bancroft's reference, in 1769, to the belief that flies transmit the tropical disease known as "yaws." It is not generally known that as early as the sixteenth century there was definitely promulgated the theory that flies play a rôle in the transmission of the plague.

Dr. Josiah Nott, 1849, lists Athanasius Kircher as among the earlier writers who believed that insects served as transmitters of disease. Dr. Kelly, in his fascinating volume "Walter Reed and Yellow Fever," goes further and quotes from Kircher's "Scrutinium Physico-medicum," published at Rome in 1658, the remarkable statement:

> There can be no doubt that flies feed on the internal secretions of the diseased and dying, then flying away, they deposit their excretions on the food in neighboring dwellings, and persons who eat it are thus infected.[1]

Unfortunately, Dr. Kelly's translation stops

[1] Apropos of the present-day belief that blood-sucking and stinging insects may occasionally be direct inoculators of disease germs, the following statement from the same work is of interest: "In a recent plague at Naples, while a certain nobleman was looking out a window a hornet flew in and lighted on his nose and stinging him with the sharp point of its proboscis, caused a swelling. And when the poison had gradually spread and crept into the vital organs, within a space of two days (without doubt from the contagious humours which the insect had sucked up from a corpse), he contracted the disease and died."

just short of Kircher's clause in which he attributes this theory to Mercurialis.

Mercurialis, a celebrated Italian physician, who lived from 1530 to 1607, was one of the encyclopædic writers typical of the period. I have searched the available volumes of his works, including several editions of his extended treatise on the cause and nature of the plague.[2] So far I have failed to locate the reference in question, but it is evident that Kircher was indebted to Mercurialis for the suggestion.

The statement of Mercurialis can be regarded as no more than a lucky guess, but to Kircher we must give more credit. This astute Jesuit, born in 1601, was an indefatigable worker, and his writings are much more than mere compilations. There is no doubt that long before Leeuwenhoek's discovery Kircher had seen the larger species of bacteria, which he described in the following words:

> It is known to all that decaying bodies abound in worms, but not until after the wonderful invention of the microscope was it found that all putrid substances swarm with an innumerable brood of worms which are imperceptible to the naked eye, and I would never have believed it if I had not proved it by frequent experiments, during many years.[3]

Among the substances in which he found these "worms" he mentions spoiling meat, cheese, milk, vinegar and decaying serpents. He does not stop with the mere discovery, but he attributes the production of disease to the organisms, and formulates a theory of the animate nature of contagion. Interpreted in this light, the statement of Mercurialis assumes a new dignity. The germ theory of disease, which became dominant so soon after this period, fell into disrepute, to be revivified in the latter part of the nineteenth century. Only now are we putting to the test the theory of Kircher relative to the rôle which flies play in the dissemination of disease.

[2] "De pestelentia in universum, præsertim vero de Veneta et Patavina," Venice, 1577.

[3] "Scrutinium Physico-medicum," 1658 ed., p. 42. This is one of many references which might be cited. In his book "Ars magna lucis et umbræ," published twelve years earlier, there is to be found mention of these "worms," showing that Kircher's observations really had extended over "many years."

Wm. A. Riley

Cornell University

SCIENTIFIC BOOKS

A Treatise on Zoology. Part IX. (Oxford Zoological Series). Vertebrata Craniata. First Fascicle—Cyclostomes and Fishes. By E. S. Goodrich. London, Adam & Charles Black. 1909. Pp. 518, 515 figs.

This is an advanced hand-book, scholarly in treatment and brimful of facts, bringing up to date the knowledge of a growing subject. It embodies also a number of original results which for the most part are based upon anatomical data: its facts are marshalled convincingly: many of its sections are admirably treated, especially those on the theme of bone, paired-fins and urogenital system. It considers fishes fossil as well as recent: its weakest side is its treatment of the results of embryology. The illustrations are numerous, usually well selected, scores of them original and important. From the book-making standpoint, the work is the equal of those which have preceded it in the Oxford series: among details one may be mentioned which may seem trivial to a strong-wristed reader—the paper, though apparently heavy, does not weigh pounds as in the case of several hand-books newly published in the United States.

Goodrich's book, in a word, is a very valuable contribution, and its preparation must have proved a formidable task. Weak spots it has, however, and reviewers will not fail to discover them. The fact is one should hardly expect that a single writer could follow the literature of so broad a subject without an occasional slip. As it is we may safely say that Goodrich has accomplished a conspicuously better task than any of his predecessors. We may pass over proof errors, which are not rare but of the usual type, and as we thumb over the pages point out such defects as these: "Myxinoids are normally hermaphrodite," the author not knowing, apparently, that the early findings in this matter are discredited. *Læmargus*, the great Greenland shark, does not "fertilize the eggs externally" as Turner

and Lütken believed. Jungersen has shown conclusively that these early findings were based upon immature specimens. I know of no trustworthy evidence that the whale-shark "realizes the length of some seventy feet": it probably does not exceed fifty feet or thereabouts. There is, as far as I am aware, *no* "embryological evidence that the hyomandibular element in *Holocephala* has fused with the skull." The early forms like *Pterichthys* are not, I am convinced, separated from Coccosteids on the grounds which are instanced, pp. 260–261, though this is a matter upon which opinions of specialists may differ. "*Palæospondylus* can not be a larva on account of the centra present," but it is none the less a fact that larval forms, fish or amphibian, are not uncommon in which well-grown centra are present. Goodrich again assumes a "pineal eye" in petromyzonts, though it is only fair to admit that this organ may not *sensu stricto* be an eye at all, perhaps it is a temperature-appreciating organ, for one can hardly call an organ an "eye" in which a dense screen of pigment separates the image—if there be an image—from the sensory cells. On page 125 we read that "the main lateral line of the trunk runs forward on to the head": a better reading perhaps would have been that the main lateral line runs backward from the head, in view of the development of this organ. It is stated that the "yolk-sac of the Selachian protrudes from the ventral surface of the embryo often after birth," a condition which, I believe, does not normally occur. At least I have observed that in six species (in three different families) the young show at birth nothing more conspicuous than a scar to mark the disappearance of the sac.

In several details of terminology I am not sure that Goodrich has lessened our troubles. In certain cases he has created a series of popular names for groups whose technical names are already widely accepted, in some cases classic. Thus why should we adopt "Petromyzontia" and "Myxinoidea" for the well-known Müllerian names Hyperoartia and Hyperotreta? Nor is he consistent in his effort toward popularization, when he devises complicated technical names where simpler ones seem adequate. Thus in the matter of the fin supports of fishes he usually discards the well-known "radials," "basals" and "actinotriches" (or plain "dermal rays," to distinguish them from obvious skeletal rays), for such new names as "dermoptrichia," "somactidia," "lepidotrichia." Indeed it is not quite clear that these terms are as specific as the author implies. We query whether the criterion of their homology is to be based upon the details of structure instanced, for we recall that the homology of the bones of teleosts can not be determined on such finely-spun histological distinctions. Indeed, Goodrich himself reverts to the homely "radials" and "basals" when he is not on his guard (p. 302). He occasionally uses names for various structures which are far more questionable in point of homology than the fin supports noted above. Thus he refers throughout to "clavicle," "coracoid" and "scapula" in fishes, although specialists by no means agree as to their homologies in the cheiropterygian girdle.

His treatment of the teleosts will not escape criticism. Certain it is that he has cut several of the Gordian knots in which the despairing phylogenist has been entangled. Thus, undaunted by convergence, he adopts numerous (about twenty) group-names ending in "formes"—Notacanthiformes, Perciformes, Beryciformes—and from this point of view gives us a very useful summary of the groups, perhaps the best of its kind. This mode of treatment has clearly the merit of convenience—too great convenience, perhaps, for we doubt whether it expresses adequately our present knowledge of teleostean interrelationships.

Bashford Dean

A Hand-list of the Genera and Species of Birds. (Nomenclator Avium tum Fossilium tum Viventium.) By R. Bowdler Sharpe, LL.D., Assistant Keeper, Department of Zoology, British Museum. Volume V. London, printed by order of the trustees. Sold by Longmans & Co., 39 Paternoster Row,

E. C.; B. Quaritch, 11 Grafton Street, New Bond Street, W.; Dulau & Co., 37 Soho Square, W., and at the British Museum (Natural History), Cromwell Road, S. W. 1909. All rights reserved. 8vo, pp. xx + 694.

The issue of Volume V. of this great work, late in 1909, brings to a conclusion an undertaking of the greatest importance to systematic ornithologists. The first volume appeared in 1899, the second in 1900, the third in 1901 and the fourth in 1903, the whole comprising about 1,700 pages. The work is similar in plan to the late C. R. Gray's "Hand-list of Birds" (3 vols., 8vo, 1869–71, British Museum), being a list of not only the genera and species, but of the higher groups, in systematic sequence. The classification followed is that proposed by Dr. Sharpe in 1891. No one could have had a better equipment for the preparation of such a work than its lamented author,[1] who wrote the greater part of the British Museum "Catalogue of Birds," and under whose supervision the whole (27 vols., 1874–98) was prepared and published, and whose knowledge of the external characters of birds and the literature of ornithology was doubtless unequaled by that of any ornithologist the world has yet seen. His "Hand-list" is thus superior, in both method and detail, to any of its predecessors in the same field.

Under the genera references are given to preceding works where the group is monographically treated, and under the species to the British Museum "Catalogue of Birds," where full descriptions and citations of the principal references are given, or, in the case of species published since the appearance of the "Catalogue of Birds," to the original place of description; there are also often references in footnotes to authorities who have recently expressed opinions regarding the status or proper nomenclature of certain forms different from those adopted in the text. In order to secure the greatest degree of completeness and accuracy attainable, Dr. Sharpe sought the cooperation of leading authorities throughout the world, to whom he sent proof sheets of the work for revision. These correspondents numbered nearly thirty, of whom more than a fourth are residents of the United States. The work thus carries a degree of authoritativeness that could have been obtained in no other way, in respect at least to its minor details.

[1] Dr. Sharpe died on Christmas Day, 1909, after a short illness, from pneumonia, at the age of sixty-two years.

In judging a work of this character, it is important to know the view point of the author, especially with reference to the nomenclatorial standpoint and the species question. Unfortunately Dr. Sharpe was one of the few ornithologists of the older school who were unable to accept the modern idea of subspecies, and hence all the forms he has seen fit to recognize are catalogued as full species, the binomial form of names being strictly adhered to throughout the work. Hence many forms originally proposed as subspecies, and so recognized by later authorities, together with many discarded even by their proposers, are here catalogued as full species and stand on an even footing with forms of far higher taxonomic value. Their real status and relationships, or even the real worthlessness of many, are thus concealed from all but experts on the particular groups to which such forms respectively belong. While Dr. Sharpe thus catalogues "18,939 species," this number, it should be remembered, includes all currently recognized "forms" of birds, but many of them are not "species" in the commonly accepted sense, which probably do not exceed 13,000.

The nomenclature adopted is also, unfortunately, not in accord with the requirements of now commonly accepted rules. At the time when the early volumes of the British Museum Catalogue of Birds was prepared, the British Association Rules of Nomenclature, promulgated in 1842, were the only rules then in vogue, so far as rules of nomenclature were then respected. These rules provided that zoological nomenclature should date from 1766, or from Linnæus's twelfth edition of his "Systema Naturæ." Later the tenth, or 1758, edi-

tion of this work gradually became the generally recognized starting-point, and of late years has become officially so recognized in all modern codes of nomenclature. In the meantime the British Museum Catalogue had reached completion on the old basis, and a strongly grounded spirit of conservatism compelled adherence to the practises of earlier days. Hence we have in the "Hand-list" a work that, while of the highest utility as a catalogue of the genera and "species" of birds, is out of touch at many points with modern ways; but, with this fact in mind, the specialist can easily avoid the pitfalls. It should hence be remembered (1) that names, generic or specific, founded before 1766 (except Brissonian names) are here ignored; and (2) that emended forms of names are employed where a name as originally propounded is believed to have been incorrectly constructed.

It is with the greatest regret that, in reviewing the "Hand-list" from the present generally accepted standpoint of nomenclature, these criticisms seem necessary. No one can have a greater admiration for Dr. Sharpe's work in systematic ornithology than the present reviewer, who regards him as without a peer in his special field of activity, and his "Hand-list" as a fitting close to a long series of monumental works in ornithology.

J. A. ALLEN

Anfangsgründe der Maxwellschen Theorie verknüpft mit der Elektronentheorie. By FRANZ RICHARZ. 8vo, pp. ix + 245. Leipzig, Teubner. 1909.

This book, developed from a course of lectures to teachers, assumes on the part of the reader a knowledge of elementary experimental and theoretical electricity, as well as some acquaintance with analytical mechanics, potential theory and differential equations. It is not intended as in any way a complete exposition of electrical theory, but aims, and with success, to treat clearly and with precision a number of fundamental subjects, ranging from simple problems in electrostatics to the electromagnetic theory of light in media at rest. The treatment, while exact and of necessity involving many equations, is physical rather than mathematical. In the opinion of the reviewer it would be improved by making less use of potentials. Considerable use is made of dynamical and thermal analogies, and the electron theory is in evidence throughout, contributing much to the interest of the work. But few statements in the text are in need of correction. According to one of these *true* magnetism (div μH) corresponds to the magnetic pole strength of experimental physics, although a virtual modification of this statement occurs a little later. Also the electromotive force of a generator supplying power is referred to as the potential difference between its terminals on open circuit—an old error of remarkable vitality. The reviewer often wonders what one who defines the electromotive force of a generator in this way thinks about a series dynamo, for example, whose electromotive force for normal current may be thousands of volts, while its terminal potential difference on open circuit is practically nothing. According to another statement of the author, no direct experimental proof had been given, when the book was written, of the development of an electric intensity in an insulator by a changing magnetic field—the converse of the Rowland effect. It will be remembered, however, that such a proof was given some years ago by the experiments of Crémieu, as correctly interpreted by Larmor and H. A. Wilson. With only a few oversights in need of attention, the work as a whole is very free from errors. The printing is excellent.

S. J. BARNETT

SCIENTIFIC JOURNALS AND ARTICLES

THE opening (January) number of Volume 11 of the *Transactions of the American Mathematical Society* contains the following papers:

H. F. Blichfeldt: "Theorems on simple groups."

Virgil Snyder: "Infinite discontinuous groups of birational transformations which leave certain surfaces invariant."

E. B. Lytle: "Proper multiple integrals over iterable fields."

C. F. Craig: "On a class of hyperfuchsian functions."

W. D. Macmillan: "Periodic orbits about an oblate spheroid."

The December number (Volume 16, number 3) of the *Bulletin of the American Mathematical Society* contains: Report of the Princeton Colloquium of the society, by Virgil Snyder; Report of the September meeting of the San Francisco Section, by C. A. Noble; Report of the Winnipeg meeting of the British Association, by J. C. Fields; Report of the Salzburg meeting of the Deutsche Mathematiker-Vereinigung, by E. Dintzl; "Gergonne's pile problem," by H. Onnen; "The integral equation of the second kind, of Volterra, with singular kernel," by G. C. Evans; "Descriptive geometry" (review of recent works by Müller, Loria-Schütte and Wilson), by Virgil Snyder; Review of Jackson and Milne's First Statics and Martin's Text-book of Mechanics, by F. L. Griffin; "Shorter notices": Beltrami's works, by Eduard Study, Laplanche's Etudes sur les angles imaginaires and Thomae's Bestimmte Integrale und die Fourierschen Reihen, by J. B. Shaw; "Notes" and "New Publications."

The January number of the *Bulletin* contains: Report of the October meeting of the society, by F. N. Cole; "Note on the groups generated by two operators whose squares are invariant," by G. A. Miller; "The solution of the equation in two real variables at a point where both partial derivatives vanish," by L. S. Dederick; "Tables of Galois fields of order less than 1,000," by W. H. Bussey; "Bôcher's Integral Equations," by G. A. Bliss; "Shorter notices": Pasch's Grundlagen der Analysis, by F. W. Owens; Benecke's Zweidimensionale Logarithmentafel, by E. J. Townsend; Young and Jackson's Elementary Algebra, by E. B. Lytle; "Notes," "New Publications."

The February number contains: Report of the meeting of the Southwestern Section, by O. D. Kellogg; "Note on a new number theory function," by R. D. Carmichael; "Baire's Lecons d'Analyse," by E. R. Hedrick; "Infinite series" (review of Nielsen's Unendliche Reihen), by J. B. Shaw; "The collineations of space" (review of Sturm's Geometrische Verwandtschaften, Volume III.), by Virgil Snyder; "A synoptic course for teachers" (review of Klein's Elementarmathematik, Volumes I. and II.), by J. W. Young; "Correction"; "Notes"; "New Publications."

THE FORTY-FIRST GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY

The forty-first general meeting of the American Chemical Society was held in Boston in connection with the annual winter meeting of the American Association for the Advancement of Science, December 28–31, 1909. Nearly 600 chemists were present, making this the largest meeting ever held by the society.

On Tuesday, December 28, excursions were made to the breweries of Massachusetts Breweries Company and to the factories of Walter Baker & Co., chocolate and cocoa preparations, the New England Gas & Coke Co. and the Forbes Lithograph Manufacturing Co. In the evening the members enjoyed a complimentary smoker given by the members of the local section at the Hotel Brunswick.

On Wednesday the members of the society went to Cambridge, where a general meeting was held in the New Lecture Hall of Harvard University. They were the guests of the university at lunch at the Harvard Union. The following papers were read:

Report for the International Committee on Atomic Weights: F. W. Clarke.

Methods Employed in Precise Chemical Investigations: T. W. Richards.

On the Constitution of Curcumine—the Coloring Matter of Tumeric: C. Loring Jackson and Latham Clarke.

The Application of Physical Chemistry to the Study of Oleoresins: Charles H. Herty.

The Function of Chemistry in College Education: Lyman C. Newell.

The Cause of Color in Organic Compounds: Richard S. Curtiss.

The United States Pharmacopœia and the American Chemical Society: Joseph P. Remington.

J. A. R. Newlands: Chas. E. Munroe.

The Past and Future of the Study of Solutions: Louis Kahlenberg.

The Chemist's Place in Industry: A. D. Little.

In the evening the president of the society, Dr.

W. R. Whitney, gave an address on "Some Chemistry of Artificial Light."

Thursday and Friday the different divisions and sections met in the Lowell Building of the Massachusetts Institute of Technology. Two special features were a symposium on the Chemistry of Paint in the Division of Industrial Chemists and Chemical Engineers and a meeting of a special section to consider the Chemistry of India Rubber. The regular subscription banquet was held Thursday evening at the Hotel Somerset.

On Friday excursions were made to Lawrence, Mass., where the Wood Worsted Mills, the Water Supply and Sewage Experiment Station of the State Board of Health, and the New Water Filtration Plant were examined and the Fore River Ship Building Co. and the Distillery of Felton & Son, Inc.

DIVISION OF INDUSTRIAL CHEMISTS AND CHEMICAL ENGINEERS

A. D. Little, *Chairman*
B. T. B. Hyde, *Secretary*

Losses in the Storage of Coal: HORACE C. PORTER and F. K. OVITZ.

The organic matter of coal readily takes up oxygen from the air at ordinary temperatures and the coal thus deteriorates during storage in the air. The amount of this deterioration as determined by a laboratory study was found to be small (1.0 per cent. or less) when the coal was confined in bottles and a current of air passed through. It proved to be somewhat larger (over 2.0 per cent.) in the case of Illinois coal exposed to the outdoor weather. Deterioration was shown to be practically nothing during under-water storage for one year in the laboratory.

Immediately after mining coal absorbs oxygen rapidly. In one case 10 kilos exhausted the oxygen from 10 liters of air in four days. Only a very slight amount of CO_2 was formed during this oxidation. Methane, however, is exuded from freshly mined coal in considerable quantities and continues to be produced in some cases during long periods. The quantities of methane evolved are not sufficient to lower appreciably the heat value of the coal, but are of importance in producing explosive mine gas. The relative amount evolved by each coal conforms to the known gaseous character of the mine from which the coal was taken.

Outdoor tests are now being carried on by the U. S. Geological Survey in cooperation with the U. S. Navy and at the Isthmus of Panama to determine loss of heat value in coal stored in the open air as compared to that in under-water storage. Outdoor tests on Wyoming sub-bituminous coal showed a loss of five per cent. of the heat value in eight months open-air storage.

The True Melting Point of Trinitrotoluene: A. M. COMEY.

The accepted melting point of α-2-4-6 trinitrotoluene is 82°, but previous determinations vary from that figure down to 78.8°.

Careful melting point determinations were made on samples of C.P. trinitrotoluol obtained from various sources, and preparations of this substance were made in the laboratory from purified C.P. toluol, with the result that 80.5 to 80.6° was obtained as the corrected melting point in every case.

Bacterial Activity as a Corrosive Influence in the Soil: RICHARD H. GAINES.

Casting about for a theory to account for corrosion of iron and steel structures which are embedded in the soil, scientists are now giving consideration to the rôle played by bacteria. Recent work has shown that decompositions hitherto unsuspected and chemical changes in the soil are especially destructive to the iron. It has been found that acid contributions of the soil which have formed in abundance as a result of bacterial activity contribute to a large degree to the corrosive influences present. This corrosion is now known as shell rust and is often seen on steel or iron conveying pipes running through marshes or under water. Microscopic inspection of this rust shows that bacterial organisms have done the work. The following remedy for the evil was proposed: (1) Free drainage carrying off the acid solutions, (2) in localities where drainage is impossible slack lime should be packed about the metal, to neutralize acids formed as a result of bacterial activity.

Paint Films as Accelerators to Corrosion of Iron: W. H. WALKER.

Although the tendency to corrosion in iron or steel varies greatly with the condition of its manufacture, and although some samples are inferior to others, the fact remains that all iron and all steel will rust, hence the necessity of the study of the available methods of protecting such structures and the most general way is by paint. Any substance which will absorb, or combine with hydrogen, will on this account accelerate corrosion if such substance be in contact with iron. Linseed oil in its natural condition does this, and

that is why when such oil film is completely oxidized it ceases to accelerate corrosion. The influence of various pigments when they form parts of a linseed paint were discussed, and a method for quantitatively measuring this influence was described. It is believed that a development of this method may show much concerning the properties of ordinary protecting paint.

A Convenient Method of Refrigeration: J. O. Handy.

Liquid air is most convenient for temperatures below — 80° C. It costs $4 per liter and there are losses and possible breakages of containers which make its use in most cases expensive.

Carbon dioxide is satisfactory down to — 78° C. It is inefficient if used as a gas and not very satisfactory when used as the solid CO_2 snow.

The CO_2 snow dissolves freely in acetone alcohol, ether, gasoline and several other solvents of low freezing point. These solutions absorb heat rapidly from objects placed in them. They are perfectly mobile and easily handled.

Liquid carbon dioxide costs about 10 cents per pound. Three and one third pounds of liquid yield one pound of solid in two minutes if blown from the original container through canvas bags.

A mixture of 50 grams of CO_2 snow and 150 grams of acetone had a temperature of — 63° C. and caused one pound of mercury (freezing point — 39° C.) to congeal in two and one half minutes.

This method of refrigeration is useful for freezing tests of oils, for condensation of volatile substances, for precipitation of substances like paraffine from oil distillates and for general research work.

The Present Conditions of the Birch Oil Industry in the United States: Edward Hart.

The industry is one of those classed by the census takers as neighborhood industries and is carried on for the most part in the Appalachian plateau. The birch wood (*Betula lenta*) is cut into short pieces and distilled with water in primitive stills. About 50,000 pounds are produced annually. Oil of wintergreen (*Gaultheria procumbens*) is produced in the same way to the extent of 5,000 pounds. Illustrations of the stills and samples of the oil were shown.

Variations in Car-painting Practise: Carl F. Woods.

The four fundamental operations in car painting are filling the pores of the wood, smoothing down the natural inequalities of the surface, putting on the color in a smooth homogeneous film and finally covering the surface with a film of varnish. The three methods are the "lead and oil," the "surfacer" and the "color and varnish" processes. The advantages and disadvantages of the different methods are discussed. It is probable that no one of the methods embody the maximum efficiency but it has been shown that a saving of $20 to $30 can be made on the painting of each car and an increase in life obtained of from five to ten years by the adoption of scientific methods of finishing.

Some Variations in the Official Determination of Volatile Matter in Coal: A. C. Fielder and J. D. Davis.

Experimental data obtained in two different laboratories bearing on the variations in the volatile combustible matter, as determined in the official method of the American Chemical Society, are given in this paper, from which the following conclusions are drawn:

Laboratories using natural gas are apt to get results on volatile combustible matter that are considerably lower than those obtained in laboratories using coal gas unless the following precautions are observed: (1) Gas must be supplied to the burner at a pressure of not less than ten inches of water; (2) natural gas burners admitting an ample supply of air should be used; (3) air should be adjusted so that a flame with a short well-defined inner cone is produced; (4) the crucibles should be supported on platinum triangles and kept in a well-polished condition; (5) semibituminous coals should be placed in an inclined position across the corner of the bottom of the platinum crucible, to prevent the swelling up of the coke in the early stages of the heat treatment.

Results by destructive distillation in a small iron retort are practically the same as the official volatile matter in the coal.

Two laboratories may expect to vary as much as 2 per cent., both using the official method.

The following papers are reported by title:

Practical Corrosion Tests of Iron: W. D. Richardson.

Methods for Testing Commercial Anhydrous Liquid Ammonia and Results: W. D. Richardson.

The Temperature Reaction of Oil Mixtures with Sulphuric Acid: W. H. Boynton and H. C. Sherman.

A Comparison of the Accuracy of Different Formulæ for Calculating Fuel Values: H. C. Sherman and D. A. Bartlett.

Action of Liquid Anhydrous Ammonia on Rubber Gaskets: CHARLES H. EHRENFIELD.

A Simple Viscosimeter: CHAS. S. PALMER.

Lubrication, Lubricants—Oils, Greases and Solids: C. F. MABERY.

The Oxidation of Iron and Steel and how to Prevent it: J. S. STAUDT.

The Effect of Non-Metallic Impurities on the Properties of Steel: HENRY FAY.

New Methods of Asphalt Examination: ALBERT SOMMER.

A New Precision Centrifuge: H. E. HOWE.

Guayule Grinding Experiments: CHAS. P. FOX.

Incompatibilities in Chemical Manufacture: J. T. BAKER.

An Adiabatic Calorimeter for Use with the Calorimeter Bomb: FRANCIS G. BENEDICT and HAROLD L. HIGGINS.

The Weathering of Coal: S. W. PARR.

A New Gas Calorimeter: S. W. PARR.

Manufacture of Oxide of Zinc: GEO. C. STONE.

Scientific Preparation and Application of Paint: G. W. THOMSON.

The Determination of Oil in Flaxseed Products by the Specific Gravity Method: CHAS. A. HERTY and E. J. NEWELL.

DIVISION OF PHARMACEUTICAL CHEMISTRY

A. B. Stevens, *Chairman*

B. L. Murray, *Secretary*

Gamboge: F. O. TAYLOR.

Different adulterations of pipe and powdered gamboge are referred to and analytical results for starch tests, ash, alcohol solubility and acid value on fifteen samples are given. The value of the different tests and their indications, directly and by comparison, are discussed. The alcohol solubility is stated to be an unusually good means of detecting adulteration and the inclusion of a starch test in the U. S. Pharmacopœia specifications is recommended.

The Melting Point of Aconitine: F. O. TAYLOR.

Attention is called to the double melting point given by the U. S. Pharmacopœia and to the variation in this constant as recorded by different authorities. Results of 35 determinations confirm Dunstan's results of 188.5° and show that the melting point may be seriously affected by the manipulation employed. It appears that a statement of the melting point without reference to apparatus or method used is misleading and the need of some definitely stated process in the U. S. Pharmacopœia is emphasized.

Pharmacopœial Tests for Ammonium Benzoate: ATHERTON SEIDELL and GEORGE A. MENGE.

The only pharmacopœial tests for ammonium benzoate which might be expected to indicate the purity of the salt are the melting or decomposition point, and the litmus paper test for free acid. Both of these tests are shown to be unsatisfactory. In the case of the first, the decomposition point curve is almost horizontal for samples varying between pure ammonium benzoate and containing 50 per cent. of benzoic acid. The litmus paper test will not show the presence of 8 per cent. free benzoic acid. The quantitative analysis of the salt by distillation of its ammonia is recommended in preference to the "formaldehyde method" for the acid radical, although the latter method is to be preferred for the majority of the pharmacopœial ammonium compounds.

The Purity Rubric and the U. S. Pharmacopœia Tests with Notes on Quantitative Methods for Certain Pharmacopœial Compounds: ATHERTON SEIDELL and M. I. WILBERT.

The purity rubric of the U. S. Pharmacopœia is not always accompanied by satisfactory quantitative methods to determine the exact per cent. of purity of a given compound. The desirability of having satisfactory and withal simple methods of assay is generally accepted and in this paper a method for the quantitative determination of mercury is outlined, also a method for the determination of iodine as iodide. Several additional quantitative methods are referred to more briefly to illustrate the possibility of adapting more or less well-known quantitative methods of assay to pharmacopœial compounds and thus enhance the practical value of the purity rubric.

The following papers were reported by title:

Scope of Pharmaceutical Chemistry: A. B. STEVENS. (Chairman's address.)

Strychnine Sulphates: A. B. STEVENS.

The Botanical Source of the Crude Drug Known as Wild Yam: H. H. BARTLETT.

On the Availability of "Idophenine" in the Separation of Acetanilid and Acetphenetidin: W. O. EMERY.

Detection of Colocynth Seed in Powdered Colocynth: V. K. CHESNUT.

Pancreatin: JOHN P. STREET.

The Relation of the Chemist to Proprietary Medicines: W. A. PUCKNER.

Geo. D. Rosengarten, chairman of delegates of the American Chemical Society to the Pharma-

copœial Convention, led a discussion in regard to matters to be settled at that convention and received suggestions in regard to the policy that should be followed.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

Charles H. Herty, *Chairman*

Wilder D. Bancroft, *Secretary*

Ionization of Salts in Mixtures with No Common Ion: MILES S. SHERRILL.

That the mass-law does not hold for the ionization of salts is well known. A thorough examination of data relating to the ionization of salts present in water alone and mixed with other salts has led to the formulation of the following general principle.

For any salt the ratio of the product of the concentration of its ions to the concentration of its un-ionized part is a function of the total equivalent ion-concentration in the solution and of that alone.

This rule, originally stated by Arrhenius as applicable to uni-univalent salts and extended by A. A. Noyes to include salts of higher types, has already been confirmed by various investigators through conductance measurements of mixtures with a common ion.

The conductivity of solutions containing definite mixtures of potassium sulphate and sodium chloride was measured and compared with the conductivity calculated with the help of the above stated principle. The agreement confirms the validity of the principle.

Ionization of Salts in Mixtures with a Common Ion: W. C. BRAY and F. L. HUNT.

The experimental verification by conductance measurements of the principle given in the preceding abstract has been confined to mixtures of salts in which neither component was present in large excess. By taking advantage of the high mobility of hydrogen ion, an extreme case has now been investigated, viz., dilute solutions of HCl in the presence of large excess of NaCl. For each mixture the conductance, when calculated in the assumption that Λ_H (the conductance of hydrogen ion) is constant, was somewhat greater than the measured value; but the consistent nature of the deviations for all proportions of HCl and NaCl indicated that the ionization of HCl was determined by the total ion concentration and not by its absolute concentration. The transference experiments of Noyes and Sammet and Noyes and Kato show, however, that, if ACl remains constant, Λ_H increases rapidly with increasing concentration, and that the degree of ionization of HCl is almost the same as that of KCl. On using these results and assuming that the mobility of hydrogen ion depends only on the concentration of acid in the mixture, the calculated and measured values of conductances were found to agree very closely.

Heats of Combustion of Certain Liquid Hydrocarbons: T. W. RICHARDS and R. H. JESSE, JR.

In further prosecution of the revision of thermochemical data the heats of combustion of benzene and a number of octanes and xylenes were determined with unusual care. The object in choosing these substances was to endeavor to trace the effect of constitution or arrangement upon the heats of formation of isomeric substances and thus to obtain more definite idea of the relation of total energy-change to structure. The adiabatic method of calorimetry was used with great success, and in general the precautions used in previous work of this kind were adopted throughout, with several new improvements. Each specimen of volatile liquid was sealed in a flexible flattened glass bulb and ignited by means of a small weighed quantity of sugar placed above the bulbs on a glass shelf, the substances being contained in a very small narrow platinum crucible. When conducted in this way, the combustion was in every case complete. The final results showed very satisfactory agreement among themselves, and all will be soon published. This investigation will be continued in the near future, and the effort will be made to obtain as much light as possible upon the energy relations of these closely related compounds.

The Compressibilities of Certain Isomeric Hydrocarbons: T. W. RICHARDS and C. L. SPEYERS.

In continuation of the work upon compressibility, described in Publications 7 and 26 of the Carnegie Institution of Washington, and in connection with the work above summarized concerning the heats of combustion of octanes and xylenes, the compressibilities of these substances at various temperatures was investigated in detail. The effort was made to attain greater accuracy than ever before. The standard of pressure was verified to a degree of precision far exceeding anything which had hitherto been attained. The new method for determining compressibility was found to give satisfaction as before. Five octanes were investigated with great care. Their compressibilities were found to vary over a much

wider limit than their heats of combustion, being comparable to the variations in the boiling point. In general, the isomers with higher boiling points possess lower compressibility, and the greater the density the less the compressibility; but there are interesting minor variations in these relationships which deserve further investigation. Ortho- and metaxylene and ethyl benzene also were investigated. The authors received important pecuniary assistance from the Carnegie Institution of Washington.

Electrochemical Investigation of Liquid Amalgams of Thallium, Indium, Tin, Zinc, Cadmium, Lead, Copper and Lithium: T. W. RICHARDS, J. H. WILSON and R. N. GARROD-THOMAS.

The investigation was a continuation of the research concerning amalgams of zinc and cadmium, described in a recent paper by Richards and Forbes. The object was to extend the study to elements possessing other valences and to study more accurately the phenomena investigated. The electromotive forces (and their temperature-coefficients) of various cells containing amalgams of the eight metals named in the title were measured with many precautions against experimental errors. Thallium and indium were found to behave in the same manner as cadmium, but in a much more exaggerated degree. Tin and lead were found to behave in the same manner as zinc, but likewise in a more exaggerated degree. It was shown that the greater part of these deviations from the concentration law may be explained by the heat of dilution of the amalgam, according to the equation of Cady. The temperature coefficient of a cell of this type was shown to correspond closely with the requirement of this equation. The difficulties of the actual measurement of thermochemical data involving amalgams were emphasized, and many errors in the work of previous investigators were discovered. It was shown that the deviations from the simple concentration law in every case decreased as the dilution increased, so that upon reaching a concentration of 0.01 gram-atom per liter all the amalgams investigated behaved practically as ideal solutions.

Further Investigation concerning the Atomic Weights of Silver, Lithium and Chlorine: THEODORE W. RICHARDS and HOBART HURD WILLARD.

This investigation consisted in a careful study of three ratios, namely, $LiCl/AgCl$, $LiCl/Ag$ and $LiClO_4/LiCl$. By means of the latter two ratios the ratio of O_4/Ag was calculated, and new values were obtained in an entirely original way for the atomic weight of silver, lithium and chlorine. In the process of this work new methods of purifying lithium salts better than any preceding were devised. The lithium chloride was fused in such a way as to show perfect neutrality to the most sensitive indicators, and was weighed in a strictly anhydrous condition. The preparation of perchloric acid also was subjected to rigid scrutiny, and this substance was made in a state of unusual purity. A new precise method was devised for converting lithium chloride into lithium perchlorate, and its sources of error were carefully examined.

The atomic weight of lithium was found to be very nearly 6.94 (much less than Stas's value) and that of silver 107.871, if oxygen is taken as 16.000.

On the Velocities of Certain Reactions between Metals and Dissolved Halogens: RALPH G. VAN NAME and GRAHAM EDGAR.

Under like conditions the metals mercury, cadmium, zinc, copper and silver were found to dissolve in an aqueous iodine solution containing a large excess of potassium iodide at practically the same rate. In bromine mercury dissolves somewhat faster, in cupric bromide much slower than in iodine. The so-called diffusion theory of reaction velocity, of Noyes, Whitney and Nernst, seems to give a satisfactory explanation of the results obtained, as regards both the observed agreements and the change in the velocities with the conditions.

The Estimation of Radium Emanation and of Radium in Common Materials: MERLE RANDALL.

A definite quantity of radium emanation, obtained from a definite volume of a solution of the mineral uraninite, was introduced into electroscopes of the various types now in use for determining radium emanation. The values for the ionization current due to the emanation associated with one gram of uranium varied from 2.36×10^{-10} amperes for a Boltwood type to 4.80×10^{-10} for a Schmidt type. Thus it is incorrect to assume, as many European investigators have done, that data, expressed in amperes or C.G.S. units, obtained with one instrument, are directly comparable with those obtained with another. Some forms of apparatus for separating the emanation from solution removed a greater percentage than others. With all types the percentage loss was greater when the total amount of emanation present was small. Accurate de-

terminations can be obtained only when the methods and instruments are identical with those used in the standardization experiments, and the amount of emanation is also approximately the same.

On the Oxalates of Hydrazine: J. W. Turrentine.

Two oxalates of hydrazine have been prepared, the neutral monoxalate $(N_2H_4)_2.H_2C_2O_4$, and the acid dioxalate, $N_2H_4.H_2C_2O_4$. They crystallize from water in colorless plates.

The monoxalate is very soluble in water, while the dioxalate is only sparingly soluble in that solvent when cold. Both are insoluble in alcohol and ether. These salts do not exhibit definite melting points. When heated, intromolecular oxidation occurs with the formation—among other products—in the case of the monoxalate, of hydrazine hydrate, hydrocyanic acid or cyanogen, and a white crystalline sublimate which, from tests, appears to be a salt of hydrazine with an unidentified, carbonaceous acid, and in the case of the dioxalate, of ammonia, a cyanide and a white sublimate of an ammonium salt with some carbonaceous acid. A new method of analysis is described, especially applicable to the analysis of salts of hydrazine with easily oxidizable acids, whereby, with standard potassium permanganate solution, both the acid and the basic radicals of the oxalates are determined simultaneously.

Notes on the Preparation of Chromyl-Compounds: Harry Shipley Fry.

The paper is a résumé of attempts to prepare the unknown compounds chromyl bromide and chromyl iodide. While only partially successful in this respect, certain noteworthy results were obtained, namely: a new reaction for the preparation of chromyl chloride; a reaction for the detection of minute traces of chromyl chloride (0.00001 gm. per 1 c.c. of solvent) depending upon the formation and color of chromyl bromide; the preparation and identification of two new compounds—chromyl acetate and anhydrous chromic acetate.

The Solubility of Gold in Nitric Acid: Frederic P. Dewey.

Contrary to the general statement that gold is not soluble in any single acid, there are various statements in assay literature that gold may go into solution in the nitric acid during parting. After reviewing previous work upon the subject, the results of which are not, for various reasons, conclusive, this paper describes some tests upon the nitric acid after use for parting in gold bullion assays which gave most conclusive evidence that the acid did really carry gold.

These tests are followed by more elaborate ones upon larger amounts of gold and with increasing precautions. On two occasions 6 to 700 c.c. of solution were obtained, carrying more than 180 mg. of gold per liter.

A final crucial test, carried out with the utmost care, entirely in platinum, on about 30 grams of finely divided gold, by boiling it for two hours in previously boiled nitric acid of 1.42 sp. gr., yielded a solution which, after filtering, contained gold at the rate of over 660 mg. per liter.

It is shown to be very easy to dissolve finely divided gold in boiling nitric acid of 1.42 sp. gr.

On the Chief Determining Factor in the Toxicity of the Metal Ions: L. L. Woodruff and H. H. Bunzel.

Discussion of a series of experiments to determine the relative toxicity of various salts toward protoplasm. Results show a parallelism between the smallest fatal concentration of the various ions and their "ionic potential."

Metallic Titanium: Matthew A. Hunter.

The only successful preparation of pure titanium is that used by Nilson and Peterson by the reduction of $TiCl_4$ with sodium. Titanium so prepared does not differ in outward appearance from polished steel. It is however hard and brittle when cold. If however it be raised to a low red heat, it may be forged like red-hot iron. If the temperature be carried much above a low red the metal oxidizes superficially in air. Homogeneous rods 6 inches in length have been prepared and it is hoped to be able to prepare wire from them. The metal may be easily polished on an ordinary grindstone. It is too hard to be sawed by a hack saw but may be filed to shape by an ordinary file.

The specific gravity of the melted metal was found to be 4.51 at 18° C. The specific gravity of the forged material did not differ sensibly from this value. The melting point of the material is between 1,800 and 1,850° C. Analysis of the molten beads shows that the material is 100 per cent. titanium, containing no iron, sodium or oxygen as impurities.

Some New Double Arsenates: L. J. Curtman.

If to a hot ferric chloride solution, strongly acid with hydrochloric acid, diammonium arsenate solution be added to incipient precipitation, and the mixture heated, there forms a white finely divided precipitate which analysis showed to be

a double arsenate of ammonium and iron of the formula $NH_4H_2AsO_4.FeAsO_4$. Like the corresponding phosphate prepared by the author, the double arsenate readily hydrolyzes when washed with water. It readily dissolves in mineral acids, but is practically insoluble in 50 per cent. acetic acid. Ammonia dissolves it on heating to a deep reddish-brown solution from which 95 per cent. alcohol precipitates a basic double ammonium ferric arsenate. When sodium and potassium arsenates were respectively used under the same conditions, precipitates were obtained which from the results of qualitative analysis appear to be the double corresponding alkali arsenate.

Solubility Relations in Concentrated Solutions: ARTHUR E. HILL.

An effort has been made to calculate the solubility of a salt in solutions of a second electrolyte, throughout a wide range of concentrations. The lack of success of previous investigators has been due to the want of a dilution formula by which the dissociation of one salt might be accurately calculated in the presence of another, under which condition it has long been known that a change of degree of ionization occurs in addition to that brought out by chemical interaction. The formula most often used to express this "neutral salt effect" is that demanded by the isohydric principle of Arrhenius. It is known, however, that this formula always gives a calculated ionization greater than that experimentally found, and accordingly solubilities calculated by this method are always too low. Arrhenius himself, realizing the inadequateness of his formula, proposed one remedying the defect, but containing three constants. The author finds that an adequate formula may be written containing only the two constants of the Storch-Bancroft dilution formula for a single electrolyte, and proposes the expression

$$Cs = \frac{(Ca \times Ck)^{n}\left(\frac{\Sigma Ca \times \Sigma Ck}{Ca \times Ck}\right)^{\frac{n-1}{2}}}{K},$$

where Ca and Ck indicate the concentration of the anions and cathions respectively of the simple salt, ΣCa and ΣCk the total concentration of anions and cathions, and Cs the concentration of undissociated salt.

This dilution law has been used in calculating the solubility of several binary salts in presence of other electrolytes. In cases where the mixture contains no common ion, the calculated results agree with the experimental data within a few per cent. even in solutions of high concentration. In the case of mixtures containing a common ion the agreement is less nearly perfect, although in every case it is better than that obtained when the calculations are made according to the isohydric principle.

Measuring Capillary Ascension in Tubes of any Material: S. LAWRENCE BIGELOW.

An apparatus was shown with which the capillary ascension of any liquid in tubes of any material can be accurately and quickly determined.

Experimental results were given demonstrating that the ascension of water (and of benzene) was practically the same in tubes of glass, copper, silver and platinum.

The fact that water will ascend in tubes not wet by it, in tubes of paraffin, bees-wax and celluloid, was shown experimentally. The ascension in such tubes is about 70 per cent. of what it would be in glass tubes.

The ascensions of a saturated solution of sugar in a tube of sugar, and of a saturated solution of copper sulphate in a tube of copper sulphate, were measured and found to be about two thirds of the ascensions shown by the same solution in platinum tubes. Theoretical discussion of these results was deferred to the appearance of the article in the journals.

The Reaction between Bromic Acid and Hydriodic Acid in Concentrated Hydrochloric Acid Solution: D. L. RANDALL.

This paper compares the action of bromic acid and that of iodic acid on hydriodic acid in the presence of strong hydrochloric acid solution, and shows that while the reaction with iodic acid is

$$2KI + KIO_3 + 6HCl = 3KCl + 3H_2O + 3ICl$$

the reaction with bromic acid is

$$3KI + KBrO_3 + 6HCl = 4KCl + 3H_2O + IBr + 2ICl.$$

Test-tube Holder: H. EMERSON WETHERILL.

Results of three years' studies off and on on the most useful way to bend up a wire into a test-tube holder with a stand, cover glass holder feature, pinch cock, wide utility and practicability, clamp for various positions, opening by one hand.

The following papers are reported by title.

Some Observations on Phosphorescence: W. L. DUDLEY.

Solarization without Light: W. D. BANCROFT.

The Reduction of Zinc by Mercury and the E.M.F. of Zinc Amalgams: J. L. CRENSHAW.

Rôle of Water in Minerals: W. F. HILLEBRAND.

Ammonolysis of Hydrazine Sulphate: A. W. BROWNE and T. W. B. WELSH.

Quantitative Application of the Theory of Indicators to Volumetric Analysis: ARTHUR A. NOYES.

The Electrolysis of Copper Sulphate Solutions with Intermittent Current: W. LASH MILLER.

A Revision of the Atomic Weight of Phosphorus: G. P. BAXTER and GRINNELL JONES.

A Revision of the Atomic Weight of Neodymium: G. P. BAXTER and H. C. CHAPIN.

The Velocity of Saponification of Formic Esters: JULIUS STIEGLITZ.

The Influence of Acids and Alkalies upon the Activity of Invertase: C. S. HUDSON and H. S. PAINE.

Specific Heat and Heat of Neutralization of Aqueous Solutions: T. W. RICHARDS and A. W. ROWE.

The Nature of Attractive Forces: J. E. MILLS.

Changes in Volume during Solution of the Alkali Halides: G. P. BAXTER.

A Simple Dynamic Method for Determining the Boiling-Points and Vapor Pressures of Liquids or Solids with Small Amounts of Material: ALEXANDER SMITH and ALAN W. C. MENZIES.

A Method for Determining Vapor Pressures: ALEXANDER SMITH and ALAN W. C. MENZIES.

A Redetermination of Vapor Pressures of Water and of Mercury: ALEXANDER SMITH and ALAN W. C. MENZIES.

A Quantitative Study of the Constitution of Calomel Vapor: ALEXANDER SMITH and ALAN W. C. MENZIES.

Wire Silver in Ores and how it is Formed: C. E. SWETT.

The Electrical Deposition of Zinc: ELWOOD B. SPEAR.

The Determination of Antimony by the Gutzeit Method: CHARLES R. SANGER.

Molybdenum and Tungsten: COLIN G. FINK.

Cæsium Nitrate and the Mass Action Law for Strong Electrolytes: E. W. WASHBURN and D. A. MCINNES.

Cryoscopic-Cryohydric Studies: S. C. LIND.

The Influence of Temperature on the Formation of Water Gas: J. K. CLEMENT and L. H. ADAMS.

A Method for Determining the Molecular Weights of Dissolved Substances by Measurement of Vapor Pressure: ALAN W. C. MENZIES.

The Condensation of Water by Electrolytes: F. K. CAMERON and W. O. ROBINSON.

The Hydrolysis of Raffinose by Invertase: C. S. HUDSON.

A Relation between the Chemical Constitution and the Optical Rotatory Power of the Sugar Lactones: C. S. HUDSON.

A Constant Temperature Regulator: EDWARD BARTOW and FRANK BACHMANN.

A New Method of Separating Chlorine, Bromine and Iodine: LOUIS KAHLENBERG.

The Solubility Relations of Calcium Sulphate at High Temperatures: ARTHUR C. MELCHER. (Presented by A. A. Noyes.)

A New Method of Determining the Potentials between Liquids: GILBERT N. LEWIS.

Forces at the Boundary between Two Liquids: W. D. HARKINS.

Chlorsulphonic Acid and Pyrosulphuryl Chloride: CHARLES R. SANGER.

The Electrical Conductivity of the Alcohols in Liquid Hydrogen Chloride: E. H. ARCHIBALD.

D. L. RANDALL,
Press Secretary

(To be continued)

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION K AT THE BOSTON MEETING

THE sectional committee decided to hold one session, and to devote this to the discussion of a subject of general interest (especially to the entire field of physiology and experimental medicine), and to hold this meeting in conjunction with the American Physiological Society. The subject "Internal Secretion" was selected, and the following program was adopted;[1] all the papers were by invitation:

TUESDAY, DECEMBER 28, 1909, 2:30 P.M.

Joint meeting with the American Physiological Society, Lecture Room, Building B, Harvard Medical School.

Address of the retiring chairman: "Chemical Regulation in the Animal Body by Means of Activators, Kinases and Hormones," William H. Howell.

Symposium on Internal Secretion

"A General Review of the Chemical Aspect of Internal Secretion," by R. H. Chittenden.

"The Comparative Physiology of the Adrenal Bodies," by Swale Vincent.

[1] Professor Swale Vincent was unable to attend the meeting.

"The Internal Secretion of the Pancreas," by W. G. MacCallum.

"Our Present Knowledge of Thyroid Function," by S. P. Beebe.

"Metabolism after Parathyroidectomy," by J. V. Cooke.

"Physiological Consequences of Total and of Partial Hypophysectomy," by Harvey Cushing.

Executive Session (Section K).

The officers and committee members for the coming year will be:

Chairman—Frederick G. Novy.

Sectional Committee—Charles Sedgwick Minot, vice-president, 1909–10; George T. Kemp, secretary, 1909-13; Graham Lusk (one year); Jacques Loeb (two years); Elias P. Lyon (three years); William G. Gies (four years); William H. Howell (five years).

Member of the Council—Thomas G. Lee.

Member of General Committee—Clarence M. Jackson.

G. T. KEMP,
Secretary

SECTION F

AT the Boston meeting, Professor Jacob Reighard was elected vice-president for the next meeting; Professor F. I. Landacre, member of the council; Professor H. F. Nachtrieb, member of the sectional committee, and Professor E. L. Rice, member of the general committee.

Instead of the usual programs for the reading of technical zoological papers, a number of well-known zoologists cooperated in making general interest programs. The following lectures were delivered: Professor C. J. Herrick, "Evolution of Intelligence and its Organs"; Professor W. E. Ritter, "A Plea for Popular Zoology"; Professor Jacob Reighard, "The Nest-building Habits of some American Fishes" (illustrated); Dr. A. G. Mayer, "The Study of Natural History at the Tortugas Laboratory" (illustrated); Professor F. H. Herrick, "Illustrations of the Life and Instincts of Wild Birds" (illustrated); Dr. Daniel D. Jackson, "The House Fly as a Carrier of Disease" (illustrated by moving pictures furnished by Mr. Edward Hatch, Jr., of the Merchants' Association of New York, and exhibited by the Kleine Optical Co., of Boston); President David Starr Jordan, "Conservation of our Fisheries"; Professor W. E. Castle, "Recent Progress in Study of Heredity" (illustrated).

MAURICE A. BIGELOW,
Secretary

SOCIETIES AND ACADEMIES

THE TORREY BOTANICAL CLUB

THE meeting of December 14, 1909, was called to order at the American Museum of Natural History, with President Rusby in the chair.

The announced paper of the evening, on "The Reclamation of the Desert of the San Bernardino Valley," was then presented by Dr. Rusby and illustrated by some seventy lantern slides. The following abstract was prepared by the speaker.

The distinctions between desert and arid regions were explained and that under discussion was defined as being arid rather than desert, for the most part, although the production of cultivated crops without irrigation was impossible. The first settlement established was a Moravian mission near the present western boundary of Redlands. This was afterwards purchased by the Mormons, who instituted local irrigation. The first extensive irrigation operations were employed by the town of San Bernardino, the present water supply of which is about 1,200,000 gallons, obtained by the deflection of Lytle Creek, besides a large amount from deeply driven wells. This water supplies not only the requirements of the city, but those of a large cultivated area.

San Bernardino is near the western mouth of the large, somewhat horseshoe-shaped valley, from the mountains about which all the water of the valley must come, except that which falls during the rainy season, and which varies from six to twelve inches in the different parts of the valley, the larger amounts falling successively nearer the mountains. The moisture brought by the Pacific winds is precipitated in crossing these mountains during the winter season only. At the greater elevations, 10,000 to 12,000 feet, it is deposited as snow; lower, in the form of copious rains, and in the valley itself is a more or less scanty rainfall. During this period, moisture is not carried to the great interior plain of Nevada, Utah, Colorado, New Mexico and Arizona, where a dry season then prevails. In the summer, conditions are exactly reversed, no rain whatever falling west of the mountains. It thus happens that the San Bernardino valley gets its natural water supply at a time when cultivation can derive the least benefit from it and the problem is presented of preserving the winter supply and distributing it during the summer. The highly successful operations in the western part of the valley demonstrated the existence of a most fertile soil of great depth, and showed that the sole requirement for a rich agricultural region was an

abundant water supply. It was recognized that a town located at the eastern end, or top of the valley would be nearer the mountain supply and that its subterranean streams would be nearer the surface. The town of Redlands was therefore plotted, about twenty-two years ago, in an absolutely arid region. These calculations turned out to be perfect and the town of Redlands is now one of the most beautiful in the world, and surrounded by one of the most fertile of regions. Series of pictures illustrated the arid conditions which antedated irrigation, and were contrasted with others showing the rich orchards, vineyards and other cultivated tracts of the present day. Land previously absolutely worthless now yields rich dividends on a valuation of from one thousand to two thousand dollars per acre. Other pictures illustrated the snow-capped summits of winter, the humid, forest-clad slopes and the gradually changing flora of the descent to the plain. The Coniferæ of these mountains are of exceptional interest, because of their rarity or limited distribution. The very peculiar branch-system of *Pinus Sabiniana*, unlike that of any other pine, was well illustrated by several slides. It was remarked that the two fine characteristic specimens of this species exist in the Pinetum of the New York Botanical Garden. Other Coniferæ illustrated, besides many other forest species, were *Pinus Coulteri*, *Heyderia decurrens*, *Abies concolor* and *Pseudotsuga macrocarpa*.

The peculiar problems affecting the conduct of the water to the plains and its distribution to the consumer, arising from the tendency to loss through seepage and phenomenal evaporation, the legal questions arising in regard to water rights, the necessity of governmental regulation of water supplies, the methods of estimating the requirements of various crops, under different conditions, and the methods of measurement and sale of the water were discussed.

A large number of illustrations were presented showing the methods of applying water to the orchards and vineyards. Others illustrated typical fruit trees, in flower and fruit, fruit gathering, drying and packing. Many slides of very great beauty represented the street planting of trees and other methods employed to beautify the cities and their suburbs.

Percy Wilson,
Secretary

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

The 674th meeting was held on January 15, 1910, Vice-president Rosa in the chair. The evening was devoted to hearing the address of the retiring president, Mr. C. K. Wead, on "Music and Science."

The speaker gave a brief sketch of the development of music, pointing out that rhythm is its most important feature; instrumental and vocal rhythm being entirely independent. Association, and combination of sounds for beauty of form, modulation and tonality were briefly explained. As regards expressiveness the musician does not attempt to put the music expression into thought.

Musical scale was defined, and the principles involved in the scales of various nations and periods were explained, among which Helmholtz's harmonic series was mentioned. No preeminent usage to fix a natural scale exists, our scale not following any law of a vibrating body. The four stages in the development of the musical scale were described. The phonograph is expected to be of importance in the study of native music.

The 675th meeting was held on January 29, 1910, Vice-president Fischer presiding. Two papers were read.

The Sixteenth International Geodetic Conference: Mr. O. H. Tittmann, of the Coast and Geodetic Survey.

The speaker gave a brief historical sketch of the origin and organization of the International Geodetic Association. The general conferences, according to present arrangements, take place triennially, the place for holding them is selected from several invitations officially extended by the delegates from various countries.

The sixteenth conference was held in London and Cambridge pursuant to an invitation by the British government, and its sessions began in London on September 21 and ended in Cambridge on September 29, the session being opened by addresses of welcome by Minister of War Haldane and by Sir George Darwin.

All but four of the twenty-two signatory powers were represented, and among those of the western hemisphere besides the United States and Great Britain were Mexico, Chili and Argentina. This is the first conference at which Canada was represented, and the speaker indulged the hope that the progress of geodesy in Canada will be such that its reports will hereafter furnish important contributions to the triennial conference.

The order of procedure of the conference was briefly outlined. The special reports refer to the

progress of triangulation, variation of latitude, deflections of the zenith, gravity observations and mean sea level determinations and leveling.

Some of the interesting topics discussed were mentioned, among which was the great progress made in the Cape to Cairo triangulation; base measurements with tapes, the use of which was so ably defended by the Americans as against the use of wire; the variation of latitude observations, especial attention being given to the method formulated by Dr. Ross and submitted by the speaker, for observing latitude photographically at Gaithersburg, Md. Dr. Hecker reported briefly on the gravity measures made in the Black Sea, with special reference to getting data and of testing the agreement between the theoretical effect of the velocity of the ship when going in an easterly or westerly direction on the observed intensity of gravity. Baron Eötvös gave an account of investigations with his torsion balance or gravity variometer, for determining the curvature of equipotential surfaces of the geoid.

One of the most important papers read at the conference was by Hayford on the reduction of gravity observations, the main feature of his method being that isostasy is taken into account, and the topographic correction is applied for the whole earth's surface. The methods and results contained in this paper elicited the following flattering comment from Dr. Helmert that "the Americans were to be congratulated on having introduced a new epoch in geodesy."

Many courtesies were extended to the delegates through Sir George Darwin acting as the representative of Great Britain and the University of Cambridge, and as a distinguished and hospitable citizen.

Some Apparent Variations of the Vertical Observed at the Cheltenham Magnetic Observatory: Mr. J. E. BURBANK, of the Coast and Geodetic Survey.

The paper discussed some changes of level of the piers on which the Omori seismograph has been mounted at the Cheltenham Magnetic Observatory. The instrument was first operated in the variation observatory where there is no diurnal range of temperature and the annual range is only about 2° to 3° C.

With falling external temperature, as in cold waves, the top of the W.-E. pier moved toward the east and the top of the N.-S. pier toward the south; with rising temperature there was reverse movement.

The W.-E. pier showed a distinct diurnal oscillation of level on all clear days. Shortly after sunrise it began to tip toward the east, reaching its maximum east deviation about 10 A.M., then it tipped toward the west reaching its maximum west deviation about 4 P.M., and then slowly returned to its normal position. This diurnal oscillation was superposed on the changes of level due to external temperature changes. This tilting of the pier began at an earlier hour in summer than in winter and the range varied greatly on different days, depending apparently on the intensity of the solar radiation. The range of motion was greatest in winter and had a yearly average of about one second of arc. The N.-S. pier did not show any appreciable diurnal variation of level.

These results are in good accord with similar observations made at Potsdam and Wilhelmshaven, Germany, both as regards the nature and magnitude of the diurnal oscillation of the level.

In October, 1907, the seismograph was moved to a new location on a massive concrete pier in a small house about one hundred yards southeast of its former location. When the external temperature rises this pier tips towards the southeast, oppositely to the pier in the variation house. There is a diurnal variation of level in the W.-E. direction but no appreciable change in the N.-S. direction.

This oscillation begins as a tilt towards the east about 10 to 11 A.M., and reaches a maximum east deviation about 4 to 5 P.M., and then returns slowly to the normal position; it appears only on clear days. The range is about the same as in the former location, but during clear winter weather when the nights are very cold the combined effect of the solar radiation and the external temperature changes may give an apparent oscillation as great as three seconds of arc. In mild summer weather when the temperature changes are small the oscillation rarely exceeds a half second of arc.

Sudden heavy downpours of rain cause this concrete pier to tip towards the northeast by an amount in some cases as great as three or four seconds of arc. When the ground is very dry before the rain, the pier receives a semi-permanent set and does not recover its former position for several days, if at all. When the ground is already partly saturated the pier recovers its former position more rapidly.

This tilting of the pier is undoubtedly local, as it did not appear on the records obtained in the variation house.

R. L. FARIS,
Secretary

THE CHEMICAL SOCIETY OF WASHINGTON

The 195th meeting was held at the George Washington University Lecture Hall on Thursday evening, January 13, 1910, President Failyer presiding. The attendance was forty-two. The report of the treasurer was read, showing a balance of $162 on hand. The secretary reported that during the past year the society had lost 71 members and had received 65 new members. The society granted a waiver of jurisdiction to the American Chemical Society over all of Virginia, except within a radius of twenty-five miles from Washington. Twenty-nine of the members lost to the society during the past year were within this jurisdiction. The total membership was reported as 240. Twenty-three papers were read during the year, fourteen of which were scientific and nine technical in character.

The following papers were read:

"Nitrification in Soils," by K. F. Kellerman, E. R. Allen and I. G. McBeth.

"Availability of Iodophenin in the Separation of Acetanilid and Acetphenetidin," by W. O. Emery.

"The Translocation of Plant Food during the Germination of Wheat," by J. F. Breazeale and J. A. LeClerc.

Dr. Kellerman showed that the modern viewpoint is that the soil must be considered alive, a matrix supporting various definite groups of microorganisms, and suggests the possibility that bacteriological diagnoses may determine the crop-producing power of different soils and the causes thereof. Although this work is yet in its infancy, during the last few years it has been shown that the action of the different groups, and especially the nitrifying bacteria in soil samples, correlates fairly well with the productiveness of the soils under field conditions.

Dr. Emery showed that it was possible to determine phenacetin in the presence of acetanilid.

In the last paper, Mr. Breazeale showed that during germination the little plantlet absorbed 96 per cent. of the nitrogen, potassium and phosphorus within the first ten days of germination, but that the potassium was absorbed at a much faster rate than were the nitrogen and phosphorus.

President Failyer appointed V. K. Chesnut chairman of the committee on communications, and C. L. Alsberg, chairman of the entertainment committee.

J. A. LeClerc,
Secretary

THE AMERICAN PHILOSOPHICAL SOCIETY

On the evening of January 21 President Nichols, of Dartmouth College, was to have addressed the American Philosophical Society, but in consequence of an attack of grip, was unable to be present. Dr. W. W. Keen, therefore, took his place, reading a paper on "Modern Antiseptic Surgery and the Rôle of Experiment in its Discovery and Development." He described the lamentable condition of surgery prior to Lister's epoch-making discoveries, then quoted chiefly from Lister the experiments .both chemical, bacteriological, and finally those upon animals which gave Lister such a convincing proof of the value of his method that he then tried it upon man. Lister began with compound fractures, passing through abscesses, accidental wounds and finally making extensive purposeful wounds, *i. e.*, operations on the human body. This was followed by a statement of the condition of surgery at the present time, as contrasted with the pre-Listerian days.

The paper is one of the series being published by the Council on the Defense of Medical Research of the American Medical Association and will be published in full hereafter in the *Journal* of the American Medical Association.

On the evening of February 5 Professor Francis G. Benedict, of the Carnegie Nutrition Laboratory in Boston, read a paper on "The Influence of Mental and Muscular Work on Nutritive Processes." The paper described a series of metabolism experiments with a respiration calorimeter at Wesleyan University, Middletown, Conn. The influence of the sustained mental effort accompanying the taking of regular college mid-year examinations was studied. Twenty-two men spent three hours inside the chamber, during which time the water vaporized, carbon dioxide produced, oxygen consumed and heat produced were carefully measured. Compared with twenty-two control tests with the same individuals no changes in the gross metabolism attributable to mental effort were noted. A professional bicycle rider using a special form of bicycle ergometer inside the respiration chamber showed that mechanical efficiency of man was about 21 per cent. The resting energy output of 92 calories per hour was raised during severe exhausting work to over 600 calories per hour, of which 116 calories were transformed into effective work.

The Nutrition Laboratory of the Carnegie Institution of Washington in Boston is equipped with special apparatus for studying similar problems in metabolism.

SCIENCE

Friday, February 25, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE CARNEGIE FOUNDATION FOR THE ADVANCEMENT OF TEACHING[1]

THE ACTUARIAL SIDE OF THE RETIRING ALLOWANCE SYSTEM

The foundation has now had four years of history. It seems, therefore, desirable to examine as critically as possible the experience gained in this interval. It will be remembered that in each report emphasis has been laid upon the fact that the income of the foundation could sustain permanently a satisfactory retiring allowance system for only a limited number of teachers and that it was desirable to determine at as early a date as practicable the approximate load the income could carry; or, put in another way, to determine the number of teachers as well as the number of institutions which the foundation might safely include in the retiring allowance system.

For the sake of continuity I venture to state in some detail the process through which the trustees have gone.

When the first $10,000,000, with its income of $500,000, was placed in the hands of the trustees, the problem before them presented a variety of factors, some of which were of an actuarial nature, but mainly the factors were of an educational and social character.

From the actuarial standpoint the problem could be stated in several ways. Perhaps the most simple way to state it is in the following terms. Assuming one thousand college professors at an average age of forty-seven, assuming three fourths of

[1] Extract from an advance copy of the Fourth Annual Report of the president and of the treasurer.

them to have wives, assuming an average pension of $1,000, and assuming that surviving widows would receive half of the pension which their husbands had earned, what would be the probable sum necessary to set aside in order to meet the annuities which would finally result if every professor retired at sixty-five?

To answer this question one must assume a mortality table and a rate of interest. Teachers have a better expectation of life than that indicated in the American mortality tables, and it was therefore necessary to use some table which represented more nearly the expectation of life in the case of preferred risks. The best authority available for this purpose is the McClintock tables, prepared by Mr. Emory McClintock, actuary of the Mutual Life Insurance Company of New York. These tables were made up by taking into consideration all the standard annuity tables in use in 1899, such as Finlayson's table (which was for many years the standard in Great Britain), the results of the French companies and also the experience of the New York Life and the Mutual Life Insurance companies in the writing of annuities. The lives of such annuitants form very much the same class of risks which those of teachers offer. This table was adopted as the New York standard for annuities after the recent insurance investigation, the law going into effect January 1, 1907. The difference in the life expectation, as computed by the American mortality tables and by the McClintock tables, is shown in the following comparisons.

EXPECTATION OF LIFE

Age	American Mortality Tables	McClintock's Tables
30	35.33 years	35.12 years
35	31.78	31.61
40	28.18	28.08
45	24.54	24.56
50	20.91	21.11
55	17.40	17.97
60	14.10	14.65
65	11.10	11.76
70	8.48	9.18
75	6.27	6.96
80	4.39	5.13
85	2.77	3.67

Another assumption which must be made is the rate of interest. The rate prescribed by law, upon which life insurance companies base their calculations, is 3½ per cent.

Assuming this extreme case, the actuaries estimated that a capital of $10,000,000 would permanently carry such a load as that indicated for a body of approximately three thousand teachers. Some teachers will, however, die before reaching sixty-five; others will resign; but, most important of all, the bulk of teachers who reach the age of sixty-five will prefer to teach for some years longer, and the foundation receives five per cent. instead of three and a half. All of these considerations indicate that under such conditions as hold in practise such a capital would supply an average allowance of $1,500 a year to such retired teachers and their widows as are likely to be furnished by a body of three thousand professors. This estimate was given in the first annual report.

On the other hand, there are numerous facts on the other side of the argument which will occur to every one. Such an assumption provides for less than one hundred institutions (or, with the sixteen millions now in control of the foundation, for perhaps one hundred and twenty institutions, of which about one half have now been admitted). It can not provide for all the colleges of America, and this fact has been emphasized in each annual report. In addition, we have taken no account of the growth of the institutions of learning.

If we assume that Harvard and Columbia are to have in the next generation faculties of two thousand instead of two hundred, if we assume that salaries are to be greatly increased, and if we assume that every professor is to claim his retiring allowance the moment it is available to him under the rules, it is clear that the large endowment of the foundation will be inadequate for even those institutions which have been admitted.

The truth is, however, that the matter is only in a partial sense an actuary's problem; all these assumptions do not detract from the fact that a well informed and conscientious body of trustees can, with the amount of income now in their control (some $800,000), maintain a satisfactory system of retiring allowances for perhaps five thousand teachers, distributed in about one hundred and twenty institutions. To do this is mainly a problem of common sense and fairness, not one of actuarial computation.

This is the practical advice which the trustees received from the actuaries themselves at the beginning of their administration. They said:

> The problem is only partly actuarial. No man can possibly predict what will happen under any assumed method of retirement. Frame your rules according to your judgment of what will best serve the interests of the teachers, within the general estimates indicated. Reserve carefully the power to amend your rules of retirement as circumstances may require, and go forward to acquire such experience as will enable you to make permanent and final rules.

This is the course which the trustees pursued; there was really no other open to them. They adopted certain rules for the granting of retiring allowances, always accompanying the statement of the rules with the following provision:

> The Carnegie Foundation for the Advancement of Teaching retains the power to alter these rules in such manner as experience may indicate as desirable for the benefit of the whole body of teachers.

This was accompanied by the additional statement that a pension once granted would not be affected by a subsequent change in the rules.

THE ADOPTION OF THE PRESENT RULES

It was after such conference with expert actuaries that the present rules were framed. At that time a smaller number of institutions seemed likely to be eligible than has since proved to be the case. The state institutions have within the last year been made eligible, and many colleges which at that time had denominational restrictions of a legal sort have since removed them and have become thereby eligible for consideration. The most the trustees hoped for at that time was to establish retiring allowances in enough institutions to bring in the retiring allowance plan as a part of American college administration. As stated in the first annual report, pages 30, 31:

> It is estimated that an income of $500,000 will maintain a system of retiring allowances, upon the scale adopted, for something over three thousand professors. This would correspond to the admission of somewhere between one hundred and one hundred and twenty institutions to the accepted list. . . . The establishment of an effective system of retiring allowances in one hundred institutions in the United States and Canada will contribute vastly more to the introduction of the retiring pay principle in American education than the maintenance of a charitable fund for a much larger number of institutions. Once the principle is established, and in so large a number of institutions as this, it will be necessary for institutions which for any reason are not eligible to this list to provide such retiring allowances for professors from other sources. This estimate, though only an approximate one, brings squarely before the trustees the consideration of the probable limit of the fund itself.

Much thought was given to the framing of such rules as might best serve the inter-

ests of teachers. The underlying principles which seemed to be clear were these:

1. The retiring allowance must come to the teacher as a right and in accordance with fixed rules.

2. It should form a fair proportion of his active pay and a larger proportion of small salaries than of large ones, a condition which was rendered fair by paying the same proportion of the first thousand dollars of active pay to all.

3. The retiring allowance should be available at some fixed age and after some stated period of service.

4. Some account should be taken of disability.

5. The retiring allowance system should embrace in its provisions the widows of teachers who under the rules had become eligible to retiring allowances.

The question of the minimum limit at which retirement on the ground of age should be permitted was one concerning which there was wide difference of opinion. The two ages most often suggested to the trustees were sixty-five and seventy. A number of teachers argued that seventy was early enough for a fixed date for retirement. More than one teacher of prominence urged that a teacher was at his best between sixty-five and seventy (these were all men past sixty-five). On the whole, however, it seemed clear that if the right to a retiring allowance did not mature till the age of seventy, a large part of the benefit of the endowment would be lost. The trustees therefore fixed upon sixty-five as a reasonable minimum limit upon which retirement on the ground of age could be claimed, leaving the question of the continuance of a teacher's service beyond that period to be determined entirely by the college and himself. The rule which resulted from this action is as follows:

Rule 1. *Retirement on the Basis of Age.*—Any person sixty-five years of age, who has had not less than fifteen years of service as a professor and who is at the time a professor in an accepted institution, shall be entitled to an annual retiring allowance, computed as follows:

(*a*) For an active pay of twelve hundred dollars or less, an allowance of one thousand dollars, provided no retiring allowance shall exceed ninety per cent. of the active pay.

(*b*) For an active pay greater than twelve hundred dollars the retiring allowance shall equal one thousand dollars, increased by fifty dollars for each one hundred dollars of active pay in excess of twelve hundred dollars.

(*c*) No retiring allowance shall exceed four thousand dollars.

Computed by the formula: $R = A/2 + 400$, where R = annual retiring allowance, and A = active pay.

It seemed extremely desirable that a retiring allowance system should include some provision for teachers who, after long service, have become broken in health or who by physical infirmity, such as the loss of hearing, are incapacitated for their calling. Among the most pathetic cases in the profession of the teacher and those most embarrassing to the colleges themselves have been the ones in which teachers have, after faithful service, broken in health and found themselves with approaching age practically helpless. In consequence the trustees adopted a second rule providing for retirement on the ground of service, intended to meet such cases as those referred to, together with the rare cases which now and then arise when a man of real genius as a scholar might prefer to accept a smaller pension and devote himself exclusively to productive work in science or literature. The trustees realized that retirement below the age of sixty-five threw upon the foundation a larger load than the retirement of one above that age. It was believed, however, that the number of teachers who would avail themselves of retirement under

such conditions would be confined almost exclusively to those who were physically impaired, and that the load coming from this provision would be small. The second rule, providing for retirement on the ground of service, is as follows:

RULE 2. *Retirement on the Basis of Service.*—Any person who has had a service of twenty-five years as a professor, and who is at the time a professor in an accepted institution, shall be entitled to a retiring allowance computed as follows:

(*a*) For an active pay of twelve hundred dollars or less, a retiring allowance of eight hundred dollars, provided that no retiring allowance shall exceed eighty per cent. of the active pay.

(*b*) For an active pay greater than twelve hundred dollars, the retiring allowance shall equal eight hundred dollars, increased by forty dollars for each one hundred dollars in excess of twelve hundred dollars.

(*c*) For each additional year of service above twenty-five, the retiring allowance shall be increased by one per cent. of the active pay.

(*d*) No retiring allowance shall exceed four thousand dollars.

Computed by the formula: $R = A/100(b + 15) + 320$, where $R =$ retiring allowance, $A =$ active pay, and $b =$ number of years of service.

The second rule thus became a complex one, covering service and disability. In addition, the executive committee has, by the authority of the trustees, granted occasional temporary disability allowances, usually for one or two years' duration, to enable a teacher who has broken down to regain health.

A third rule provided for a pension for the widow of any teacher who, either on the ground of age or service, was entitled to a retiring allowance.

These rules have now been in operation four years. During this period an enormous amount of correspondence has gone on between the foundation and teachers and college officers in all parts of America. The rules have been criticized and examined from every point of view. It seems, therefore, an opportune moment to review the experience of the foundation in their administration and to reexamine the whole matter in the light of this experience. Before proceeding to this examination, however, some light will be thrown on the question by the testimony of the teachers who have accepted retiring allowances. I have written to each teacher who is receiving a retiring allowance and asked a frank statement of the reasons for his retirement. It is a part of the invariable policy of the Carnegie Foundation to place in the hands of those interested in education the fullest details respecting the foundation and its administration. In accordance with that policy the nature of these replies is indicated in the following summary.

THE REASONS WHY COLLEGE TEACHERS RETIRE

The inquiries just referred to were addressed to teachers on the retired list, with the understanding that individual letters were not to be quoted. The summary which follows represents, therefore, only such classification of the replies as is possible without direct quotation. The correspondence makes an interesting contribution to the history of this matter, and throws light on the varied conditions of college administration in small and large institutions and in various parts of the continent.

Letters were addressed to two hundred and eleven teachers on the retired list, asking for the purposes of the foundation a brief statement of the reasons for retirement. Replies were received in practically every case, and these were, with few exceptions, sufficiently definite to give a clear idea of the motives, or the combination of motives, which induced the writer to retire from active service.

For the sake of clearness and in order to help our discussion of the rules, it is best to consider these replies in two groups: first, the replies of those who retired after reaching the age of sixty-five under Rule 1; second, the replies of those who retired below the age of sixty-five under Rule 2.

Some one hundred and sixty-five letters were received from professors who had retired at sixty-five or over. These men can be divided as to age into two groups approximately equal in number, the one group retiring at ages between sixty-five and seventy, and the other retiring above seventy. The size of this second group is, however, probably disproportionately high because previous to the establishment of the foundation many teachers continued in service longer than they would under present conditions.

Of the whole number retiring on reaching sixty-five or later, twenty-seven, or nearly one sixth, state that their retirement was distasteful to them. They were, in their judgment, in full vigor of mind and body, but either on account of some statutory provision of their college, or by reason of the advice or wish of the college administration, they felt their retirement to be necessary.

In addition to the twenty-seven men who state frankly that they retired against their own wishes and judgment, there is a considerable group who indicate that they were induced to ask for a retiring allowance through a foreboding on the subject of age. They retired not on account of pressure from the administration or on account of a statutory provision, but because they wished to anticipate the formal suggestion of such action.

Various personal considerations were given for retirement of a sort which do not permit classification. For example, a few professors in small colleges felt the burden of too much elementary teaching and the hopelessness of relief in view of the poverty of their colleges. Under such circumstances, they preferred to retire altogether from teaching. A small group retired out of dissatisfaction with the attitude of their colleges toward their subject; one teacher thought that a wise husbandry of the college's resources demanded the abolition of his department. Recent revolutionary changes in science caused five men between sixty-five and seventy-five to conclude that younger men were more capable of adapting class-room methods to the new discoveries. Two frankly stated that their scholarship seemed to them to belong to an older generation, and it was too late to begin the mastery of new methods.

The largest group—fifty-two in all, nearly one third of those retiring on the ground of age—wrote in a serene and cheerful spirit. In the main the tenor of their letters was to the effect that they had discharged their duties to their profession, and with growing bodily infirmities they were glad to retire from active duties as teachers to some long-deferred study or research. These men wrote with grateful hearts concerning the opportunities for work which their profession had given them, and with equal gratitude for the provision which enabled them to look forward to a quiet and useful old age. If any man is discouraged over the outlook of the American scholar, he will get new faith by reading the letters of these veterans, some of whom had filled professors' chairs for sixty years.

From teachers who had retired under the provision of Rule 2 and who, on retirement, were below the age of sixty-five, forty-two letters were received. Of these only twelve had retired on the ground of

impaired health—four (ages fifty-nine, sixty-one, sixty-three, sixty-four) suffering from defective eyesight or hearing, and eight (ages fifty-four, fifty-six, fifty-eight, fifty-eight, sixty-one, sixty-two, sixty-four, sixty-four) having developed some malady or incurred a general breakdown in health. Of the remaining thirty, ten (ages two each at fifty-two, fifty-four, sixty-two, sixty-three and sixty-four) retired on account of some college complications, five of them stating explicitly that their resignations were requested by the presidents of their respective institutions or that they were dismissed.

Twenty still remain to be accounted for. These were in good health and in their own judgments capable of teaching satisfactorily. Five (ages fifty-five, sixty, sixty, sixty, sixty-three) desired to engage in the work of research or other professional labor, with the additional reason in one case of dissatisfaction with the attitude of the student body and in another the fear that the college might prefer retirement. Two (ages sixty and sixty-three) took advantage of the opportunity for family reasons; two (ages sixty-one and sixty-three) thought that younger colleagues ought to have the chance to occupy the positions they held; five (ages fifty-one, fifty-seven, fifty-eight, sixty, sixty-two) desired to engage in business; six (ages fifty-one, fifty-four, fifty-six, sixty, sixty-two and sixty-three) desired recreation and relief from the recitation and lecture room.

The statements by these two groups of men are most illuminating in respect to the actual working of such provisions as are incorporated in the present rules.

THE WORKING OF THE RULES FOR RETIREMENT AND THEIR BETTERMENT

The following table shows in condensed form the financial load which has resulted in accepted institutions under the operation of the rules as they have hitherto stood. The statement is confined to the accepted institutions for two reasons—first, the teachers in these institutions are the only teachers who have had free opportunity to avail themselves of the retiring allowance provisions; and secondly, these institutions contain the only body of teachers for whom the foundation has accepted permanent responsibility.

COST OF RETIREMENTS AT THE AGE OF SIXTY-FIVE OR OVER

Year	No. of Accepted Institutions	No. of Teachers in Faculties	No. of Retired Teachers on Roll	Average Age at Retirement	Annual Grant of Retiring Allowances	Number of Widows Pensioned	Annual Grant of Widows' Pensions	Total Annual Grant at End of Year	Deductions through Death	Annual Load at End of Year
1905–6[a]	52	2,261	34	71.4	$ 52,365	3	$2,700	$ 55,065		$ 55,065
1906–7	55	2,309	64	70.7	99,160	5	4,340	103,500	$13,710	89,790
1907–8	62	2,444	85	70.7	136,365	5	4,020	144,405	3,880	140,525
1908–9	67	2,966	129	70.6	214,250	11	7,995	222,245	1,940	220,305

COST OF RETIREMENTS AT AGES BELOW SIXTY-FIVE ON BASIS OF SERVICE

Year	No. of Teachers Retired below 65	Average Age at Retirement	Annual Grant of Retiring Allowances	No. of Widows Pensioned	Annual Grant of Widows' Pensions	Total Annual Grant at End of Year	Deductions through Deaths	Annual Load at End of Year
1905–6	5	62	$ 9,395	1	$ 600	$ 9,995		$ 9,995
1906–7	15	60.3	25,810	6	5,125	30,935	$2,190	28,745
1907–8	26	59	39,460	14	13,205	52,665	600	52,065
1908–9	40	58.6	62,355	21	20,390	82,745	4,745	78,000

[a] June to October, 1906.

ALLOWANCES FOR TEMPORARY DISABILITY

Year	Number	Amount
1905–6	8	$11,675
1906–7	10	14,215
1907–8	14	22,615
1908–9	17	28,235

The discussion of these statistics will be most profitable if the two groups are again considered separately.

(A) *Retirements on the Ground of Age (Rule 1)*

On the whole the results obtained under the use of this rule present a satisfactory outcome. Teachers who have passed the minimum age at which a retiring allowance may be claimed have apparently availed themselves of the opportunity to retire in much the manner in which the trustees had anticipated.

With regard to the objection voiced by a considerable group that they were retired while still capable and eager to discharge their duties, a word may be said. The question of compulsory retirement at a fixed age is one which has been much discussed. Several institutions have adopted such a rule, the age of retirement being fixed at ages ranging from sixty-five to seventy years.[4] In the case of any individual the active service may be lengthened by action of the college trustees. The question whether compulsory retirement is a wise provision in an institution of learning is one upon which something may be said on both sides.

It is clear that the artificial closing of the work of a great teacher is a matter to be regretted, and in the active professions of the world sixty-five, or even sixty-eight, is a period in which many men do their best work. In trade, in politics and in the profession of the law the years between sixty-five and seventy are those in which men assume successfully the heaviest responsibilities. Viscount Morley at seventy-one is framing a new plan of government for an empire of three hundred million people. Chief Justice Marshall guided the deliberations of the Supreme Court of the United States with unabated vigor until his death at eighty. Lord Palmerston first became Prime Minister of England in his sixty-ninth year. Von Moltke was seventy at the beginning of the Franco-Prussian War. It would have been a great loss to scholarship to have retired at sixty-five Bunsen, who taught at Heidelberg until he was seventy-eight; or Von Ranke, who taught at Berlin until he was seventy-six; or Von Ranke's colleague, Mommsen, who was still teaching when he died at the age of eighty-six. The University of Glasgow would have suffered if it had not permitted Lord Kelvin to occupy his professorship until his voluntary retirement at seventy-five, and the University of Jena is a stronger institution because Ernst Haeckel is still professor of zoology there, in his seventy-sixth year. Lord Acton was sixty-one before he began his eleven years' fruitful service in the chair of modern history at Cambridge, and Edward A. Freeman was the same age when he accepted the corresponding chair at Oxford. Upon Freeman's death in his seventieth year he was succeeded by James Anthony Froude, then seventy-four. It

[4] The following institutions have adopted more or less definite regulations for the retirement of professors upon reaching a given age. In most instances provision is made for the extension of the age limit by the trustees: University of Cincinnati, 65 years; Cornell University, 65; Dartmouth College, 70; Harvard University, 60 voluntary, 66 compulsory; Grinnell College, 70; Leland Stanford Junior University, 65; Marietta College, 65; Oberlin College, 65 voluntary, 68 compulsory; New York University, 65; University of Minnesota, 68; University of Pittsburgh, 65 (tacit understanding, but no rule); Swarthmore College, 65; Vassar College, 65 voluntary, 70 compulsory; Williams College, 65 voluntary, 68 compulsory; Yale University, 65 voluntary.

is also evident that the fixing of an arbitrary limit causes some apprehension to men approaching that period.

All this, however, does not affect the fact that notwithstanding the presence of notable service by men of seventy and upward, the average man of ability does not attain to such achievement, and that the average men are inclined to cling to their regular duties and to their official positions after their efficiency is seriously impaired. It is not easy for the individual to differentiate between those motives which are egoistic and those which are not. Few men at seventy are critical judges of their own efficiency. While, therefore, a fixed and invariable rule for the retirement of a teacher may not be the best solution, it is clear that the college professor at such an age ought to be willing to leave the question of retirement, in some measure at least, to the judgment of others. As our American institutions are organized, it is not easy to keep men in position who render partial service.

There is another view of retirement voiced by some of these teachers which seems worth notice, and that is the fear of lack of some agreeable and useful way of spending one's time if regular teaching duties are given up. We are accustomed to this attitude in the case of the business man, but one scarcely expects to find a scholar at a loss to know how to entertain himself in old age. The situation suggests, at least, that college professors do not always have sufficiently broad foundations for their scholarship nor adequate connection with varied and enduring human interests.

Only one serious criticism has been made of this rule. It is urged that the rule does injustice to the profession of the teacher by excluding service in the grade of instructor from counting toward the earning of a retiring allowance. It is urged that the position of instructor[5] is one calling for high professional training; that it belongs to the recognized professional grades of university work; that the work of an instructor in one of the large universities is often of a higher order and involves greater responsibility than that of an assistant professor in a small college; and finally that the actual work of teaching in the large institutions has for the last two decades fallen in increasing measure upon the shoulders of the instructor. These criticisms are valid ones. There is a further effect noticeable under the present rules the tendency of which is bad, namely, the pressure upon colleges to appoint men to faculty places in order that the term of service may begin to count toward a pension. This pressure is natural; it is difficult to withstand; and it is almost wholly bad. Advancement in salary and eligibility to a pension ought not to depend on promotion to an assistant professorship. I therefore recommend the amendment of this rule so as to include recognition of the service of the teacher in the grade of instructor.

The practical question which arises is: "How much ought the term of service to be lengthened in order to include service as an instructor?"

This question is not easy to answer, since the statistics of ten and twenty years ago do not fit the experience of to-day. Men were appointed twenty years ago to instructorships at an earlier age than to-day. In fact, the place of instructor is to-day a different one. Furthermore, in the smaller colleges service in this grade lasts usually only a short time, while in the large universities it may last five or ten years, and

[5] The position of lecturer in Canadian universities corresponds to that of the instructor in the United States.

in some cases, and those of worthy and useful teachers, it lasts indefinitely. The experience of a group of the smaller strong colleges[6] indicates that instructors are appointed between the ages of twenty-three and twenty-six, on the average at twenty-four and seven tenths. On the other hand, the experience of a group of the stronger universities[7] indicates that instructors in these institutions begin their service between the ages of twenty-five and thirty, or on the average at twenty-eight. Each group is geographically well distributed. On the whole, it would be fair to assume that a man who is appointed an instructor at twenty-five will either be an assistant professor at thirty-five or earlier, or will remain permanently an instructor. If the rule for retirement on the basis of age is therefore amended so as to read: "Any person sixty-five years of age who has had not less than fifteen years' service as a professor or not less than twenty-five years' service as an instructor, and who is at the time either a professor or an instructor in an accepted institution," etc., the service of a teacher in the grade of instructor will be fully recognized. I recommend this change.

(B) *Retirements under Rule 2*

The outcome of an unrestricted opportunity to retire after twenty-five years of service as a professor is evident on the financial side in the fact that under this provision annual pensions to the amount of $78,000 have resulted in three years, an amount greater than twenty-five per cent. of the whole cost of the retiring allowances of those retired under Rule 1. This is a result far beyond the anticipations.

[6] Haverford, Grinnell, University of the South, Bowdoin, Cornell (Iowa), Beloit, Allegheny, Lawrence, Lake Forest, Rose Polytechnic, Hobart, Knox.

[7] Columbia, Harvard, Wisconsin, Leland Stanford Junior, Toronto, Northwestern, Iowa, Indiana.

The expectation that this rule would be taken advantage of almost wholly on the ground of disabilities has proved to be ill founded. Of the forty teachers retired on this basis only twelve retired for physical reasons. The average age of those thus retiring was sixty and three tenths, while twenty-eight retired on other grounds at an average age of fifty-nine years. In the first group were only five below sixty, the minimum age being fifty-four; in the second there were eleven below sixty; three retiring at the age of fifty-four, two at the age of fifty-two and two at the age of fifty-one.

These retirements indicate that when a teacher has reached the age when he may claim the minimum pension, he may be put under pressure to retire whether he desires retirement or not. It has been urged that one of the benefits of the foundation consists in the opportunity thus afforded the colleges to get rid of teachers who have worn out their usefulness or who have lost interest. Whatever there may be in this claim, it is evident that it is more than counterbalanced by the opportunity which is thus opened to bring pressure to bear on the teacher, or by the tendency of the teacher assured of a retiring allowance to become ultra-critical toward the administration. The situation is not a good one either from the standpoint of academic freedom or of academic contentment. Furthermore, it is no part of the function of a retiring allowance system to care for the disagreements of college life. These are problems of administration.

The idea that the foundation could indirectly give aid to research by the retirement below the age of sixty-five of some man devoted to research rather than teaching is also one which, on the whole, seems elusive. The correspondence outside of these letters indicates that a number of

teachers have persuaded themselves that they are specially intended for research. Some of these have a small income which, even with the minimum pension, promises a safe, if not ample, support. Others are "tired of teaching." It seems that this rule offers too large a temptation to certain qualities of universal human nature. Furthermore, the object of the Carnegie Foundation is not the encouragement of research (desirable as that may be), nor is it concerned with the transfer of men from the calling of the teacher to some other. Its object is the advancement of teaching. Experience seems to prove that the attainment of that object lies in providing security and protection to those who remain in that calling. It seems to me that Rule 2 in its present form is a mistake. As I am in the main responsible for this, I have sought in the light of experience and through consultations with numbers of teachers to ascertain what changes can at this time fairly and wisely be made. I have also sought to obtain the opinion of actuaries and others as to the general results of service pensions. The literature of this subject is meager, but the testimony from all sources seems to indicate that, while a disability pension is a helpful feature of retirement plans, a service pension ought to rest on the basis not of a minimum but of a maximum service. It is clear also from correspondence and consultations with teachers that the features of the present service pension which are most highly valued are the protection to the teacher after twenty-five years of service in case of disability, and the protection of his widow in the case of death. These two features should, in my judgment, be preserved. I recommend, therefore, that Rule 2 be amended in such manner that retirement at the end of twenty-five years of service, and before the age of sixty-five, be available to a teacher only in case of disability so serious as to unfit him, as shown by a medical examination, for the work of a teacher. Such a change will command the approval of the great body of devoted and able teachers and is in accordance with the spirit of the rules as originally framed.[8]

One other feature of the administration of these rules has proven difficult and in some respects unsatisfactory. This is the retiring of professors in the schools of medicine and law.

It is important that the medical school and the law school become more closely parts of the general system of education and more truly related to universities and university ideals. This result is coming, and an increasing number of teachers in schools of both medicine and law are giving their entire time to teaching and to investigation. At the present time, however, the bulk of teachers of law and of medicine are practitioners. The presence of such men in the schools is desirable, but the retiring allowance system was never intended for them. As matters now stand, however, it is difficult to determine where the line should be drawn in the cases of such professors. The rule provides at present that "teachers in professional departments of universities, whose principal work is outside the profession of teaching, are not included." This does not seem definite enough. The question as to whether the practise or the teaching is the principal work of a teacher of law or of medicine remains to a considerable extent a question of individual estimate. It seems desirable

[8] The changes here recommended by the president of the foundation were adopted by the trustees at their annual meeting on November 17, 1909, and the rules as so amended and as they are now effective will be found in an appendix to this report.

to amend this rule in such manner as to make the intent more definite.

In the use of the privileges of the foundation under such rules it ought not to be forgot by presidents, trustees and teachers that this noble gift for education was intended to serve primarily the faithful and efficient teacher, not to solve the difficulties of administration. The president of an accepted institution should keep in mind the purposes of the foundation as well as the wants of his college and the requests of individuals. . To throw upon the foundation a load it was not intended to carry is to limit later the service it was originally designed to fulfil.

THE EIGHTH INTERNATIONAL CONGRESS OF APPLIED CHEMISTRY

ON the evening of February 3, 1910, an informal gathering took place at which there were present among others, most of those to whom had been delegated the task of providing for the creation of an organization for the eighth International Congress of Applied Chemistry, by the London Congress last June; a representative of the Association of Manufacturing Chemists, the American Chemical Society, the American Electrochemical Society, the Society of Chemical Industry were each also present at this informal meeting.

The consensus of opinion was that the greatest success could be expected only if the most effective system and mode of organization could be had, and if each and every chemist in the United States could be made to feel that he himself directly or indirectly through his professional, business or educational affiliations, had a personal share of responsibility in the conduct and management of the congress from its very start and to its very end. This was regarded as the proper and correct guide in proposing any plans or schemes of organization.

The eighth congress is to convene in 1912 with Professor Edward W. Morley as honorary president and Dr. W. H. Nichols as acting president at a time and place to be determined by the organization of this congress. The most important part of the congress, in fact that by which its value and real success will be measured, is the amount of original matter, both scientific and technical, which it will be able to present to its members. To this end, every chemist in America who has or may have any original matter to present to this congress should begin without delay to prepare such matter, and have it in shape so that it may be presented to the congress in ample time for proper printing, classification and distribution to members and the technical and scientific press.

The congress, being held in the United States, will, with a great deal of right, naturally look to a very good showing from the chemists of the United States, and every chemist in this country, which is to be host to our foreign colleagues, should constitute himself a committee of one to get from himself, or from his friends, as much scientifically or technically valuable material as possible so that the proceedings and publications of the eighth congress may correctly reflect the true mental attitude of the chemists of the United States towards their profession, both as a pure science and as a part of the industrial activities of this country.

It is the hope that the program committee will be able to begin its activities effectively before the close of 1910, but in the meantime it behooves every chemist in the United States actively and energetically to consider how and in what way he can best contribute to the success of this congress, and particularly in the direction of papers and communications to the congress embodying the advance in this field since June, 1909, the date of the last congress.

At a meeting to be held in April or May, 1910, by those charged with the duty of providing suitable organization for the eighth congress some definite action as to such organization may be looked for. Those who have that responsibility are making every effort to get as many suggestions as to divisions of organization, mode of organizing and membership of the organization as possible. Every

one interested in having this organization on as broad foundation as possible is earnestly invited to present any suggestions that may be helpful in that direction, in writing by the middle of April, 1910, so that all these suggestions may be properly classified and collated and put in condition for most thorough consideration before the meeting above referred to actually takes place. Such communications may be addressed to the temporary secretary, Dr. B. C. Hesse, 90 William Street, New York City.

THE GRAZ INTERNATIONAL ZOOLOGICAL CONGRESS

The committee having the affairs of the congress in hand have secured reduced rates on all of the railroads of Austria for the members and participants in the congress. First-class travel will be given on payment of second-class fares, and second-class for third-class fares. This applies not only to the excursions but to all railway travel in Austria from the moment the boundary is crossed, and is available from the tenth of August until the tenth of September. To avail themselves of this privilige members must have their membership cards before reaching Austria, and therefore they should send the fees for membership to the Steiermärkische Eskomptebank, Graz, Austria, so that the membership cards may reach them in good season. The money may be sent by postal order. Those who have not yet received the preliminary circulars of the congress, with the blanks for membership and excursions, should address the Praesidium des VIII Internationaler Zoologenkongress, Universitätsplatz 2, Graz, Austria. A second circular relating to the congress will probably be issued in March or early April. This will be sent to all whose names have been sent in, either as probable members or as desiring further information. It may be well to say that all persons intending to attend the congress should engage their return passage to America at the same time that they obtain their outward accommodations. European travel promises to be very heavy this year, and early application is advisable.

SCIENTIFIC NOTES AND NEWS

Lord Rayleigh has been elected a foreign associate of the Paris Academy of Sciences in succession to the late Simon Newcomb. Sir Patrick Manson has been elected a foreign correspondent in the section of medicine and surgery.

The Edison medal of the American Institute of Electrical Engineers was presented to Professor Elihu Thomson at the annual dinner of the institute on February 24.

For the meeting of the British Association for the Advancement of Science, which is to take place this year at Sheffield, beginning on August 31, under the presidency of the Rev. Professor T. G. Bonney, F.R.S., the following presidents have been appointed to the various sections: Section A (Mathematical and Physical Science), E. W. Hobson, F.R.S.; Section B (Chemistry), J. E. Stead, F.R.S.; Section C (Geology), Professor A. P. Coleman, Ph.D.; Section D (Zoology), Professor G. C. Bourne, D.Sc.; Section E (Geography), Professor A. J. Herbertson, Ph.D.; Section F (Economic Science and Statistics), Sir H. Llewellyn Smith, K.C.B.; Section G (Engineering), Professor W. E. Dalby, D.Sc.; Section H (Anthropology), W. Crooke, B.A; Section I (Physiology), Professor A. B. Macallum, F.R.S.; Section K (Botany), Professor J. W. H. Trail, F.R.S.; Section L (Educational Science), Principal H. A. Miers, F.R.S.

The Athenæum Club has elected under the provisions of the rule which empowers the annual election of nine persons "of distinguished eminence in science, literature, the arts, or for public services," Mr. William Bateson, F.R.S., director of the John Innes Horticultural Institute, Merton, and Professor Henry Taylor Bovey, F.R.S., dean of the faculty of applied science of McGill University.

Dr. A. R. Forsyth has resigned the Sadlerian professorship of pure mathematics at the University of Cambridge.

Sir William Huggins, F.R.S., the eminent astronomer, celebrated his eighty-sixth birthday on February 7 at his residence at Tulsehill.

DR. LAWRENCE F. FLICK, who has resigned from the Phipps Institute, Philadelphia, was the guest of honor at a dinner at the University Club on February 2. Dr. Flick was presented with a massive silver loving-cup, bearing the engraved autographs of the members of the staff.

M. EMMANUEL DE MARGERIE has been elected president of the Paris Geographical Society.

SIR ERNEST SHACKLETON has been presented with the Constantine gold medal of the Russian Geographical Society.

MR. BION J. ARNOLD has been appointed chief engineer of subways of Chicago, and will organize the work of constructing a system of subways for that city.

DR. RHODAIN will be the head of the Belgian sleeping sickness mission to the Congo. The mission proposes to make its center of work the Kalengwe Falls, in the neighborhood of which the disease is very prevalent.

MR. JOHN CLAUDE FORTESCUE FRYER, B.A., Gonville and Caius, has been appointed to the Balfour studentship at Cambridge University. A grant of £200 from the Balfour Fund has been made to Mr. Clive Forster Cooper, M.A., Trinity, for an investigation into the Tertiary vertebrate fauna of India, and a grant of £40 to Mr. Kenneth Robert Lewin, B.A., Trinity, in furtherance of his work in protozoology.

PROFESSOR WILLIAM T. SEDGWICK, of the Massachusetts Institute of Technology, and Mrs. Sedgwick expect to leave this country in March for a European trip.

MR. ROOSEVELT will deliver the Romanes lecture at Oxford University on May 18.

DR. BERNARD BOSANQUET, formerly professor of moral philosophy in St. Andrews University, has been asked by the Senatus of Edinburgh University to become the Gifford lecturer for the usual period of three years, from October, 1911.

DEAN F. E. TURNEAURE, of the College of Mechanics and Engineering of the University of Wisconsin, gave two addresses before the instructional staff of the College of Engineering of the University of Illinois on February 10 and 11. His subject on the first day was "The Stress in Bridges under the Load of Moving Trains," and on the second day, "Some Features of the Manhattan Suspension Bridge."

M. ETIENNE BOUTROUX will sail for the United States on the steamship *Adriatic* on February 23, to deliver a course of lectures at Harvard University. He will also make four public addresses at Cambridge under the auspices of the Cercle Français on the "Essence of Religion" and the "Movement of Contemporary Philosophy."

A TABLET has been erected in memory of Robert Henry Thurston in the rooms of the American Society of Mechanical Engineers in the Engineering Societies building, New York City. Dr. Thurston was the first president of the society.

MR. and MRS. F. W. WEST, of Seattle, have endowed at Stanford University a lectureship to be known as the "Raymond F. West Lectureship on Immortality, Human Conduct and Human Destiny." It is arranged that at intervals of two years three lectures shall be given, by men standing in the front rank of eminence in this and other countries. The first course will be given in the year 1911. This course is in memorial of a son of Mr. and Mrs. West, a former student of Stanford University.

THROUGH a committee formed to perpetuate the memory of the late Mr. Benn Wolfe Levy a studentship in biochemistry in the University of Cambridge has been endowed with £3,000.

DR. HENRY WILDE has offered the University of Oxford the sum of £600 for the foundation of an annual lecture on astronomy and terrestrial magnetism, in honor and memory of Edmund Halley, some time Savilian professor of geometry.

DR. CHARLES PAINE THAYER, professor emeritus at the Tufts Medical School, died on February 13, at the age of fifty-seven years.

DR. HENRY BYRON NEWSON, professor of mathematics in the University of Kansas, known for his work on the theory of groups,

died suddenly on February 18, at the age of fifty years.

SIR CHARLES TODD, F.R.S., well known for his astronomical and meteorological work in South Australia, has died at the age of eighty-three years.

PROFESSOR W. HILLHOUSE, until recently professor of botany in the University of Birmingham, has died at the age of sixty years.

PROFESSOR F. PURSER, professor of natural philosophy in the University of Dublin, and the author of works on mathematics, died on January 28, at the age of seventy years.

DR. J. VOLHARD, professor of chemistry at Halle, author of the "Life of Liebig," published last year, has died at the age of seventy-five years.

THERE will be a civil service examination on March 3 to fill two vacancies in the position of ethnologist (male), Bureau of American Ethnology, Smithsonian Institution, at an initial salary of $1,500.

THE beautiful new lecture hall of the Academy of Natural Sciences of Philadelphia was opened with a short address by Dr. Edward J. Nolan to the Delaware Valley Naturalists' Union on the afternoon of January 29, preceding a lecture by Witmer Stone, one of the curators, on "The Conservation of Bird Life in the United States." The new lecture room has a capacity of 500 and is a great improvement, acoustically and otherwise, on the one heretofore used. The latter will be fitted up as one of the museum halls in remodeling the building in connection with the completion of the new wing, in which the library has been successfully installed. In the old hall vacated by the library the geological and paleontological collections will ultimately be arranged.

ARRANGEMENTS have been perfected between Captain Roald Amundsen and the Department of Terrestrial Magnetism of the Carnegie Institution of Washington regarding cooperation in magnetic work on the proposed Amundsen polar expedition to leave Norway this summer on Nansen's vessel, the *Fram*. After some general explorations in the South Atlantic and in the South Pacific Oceans, the *Fram* is expected to arrive at San Francisco in the summer of 1911. After outfitting there, she will head for Behring Sea and after entering the polar basin will then drift with the ice. It is expected that it will be about four years before she emerges again from the ice. While Captain Amundsen hopes that his vessel will drift across the North Pole or close thereto, his prime object is that of general geographic exploration. Dr. Harry M. W. Edmonds has been selected by him to fill the difficult post of surgeon and scientific observer. Dr. Edmonds had previously received training in magnetic observations while Dr. Bauer was in charge of the magnetic work of the Coast and Geodetic Survey; he furthermore has had experience in polar regions and was in charge of the Sitka Magnetic Observatory from the date of its establishment. He reported at Dr. Bauer's office in Washington early in February for the purpose of making the necessary preliminary arrangements and perfecting the instrumental outfit to be used. He expects to leave for Norway next June. Similar instruments will also be used on Captain Scott's Antarctic expedition. As the result of an effective cooperative arrangement with the recently returned Canadian Arctic expedition on the *Arctic,* commanded by Captain Bernier, the Department of Terrestrial Magnetism has just been furnished by Professor R. F. Stupart, director of the Canadian Meteorological Office, with the observations made by the special observer on board the *Arctic,* Mr. Jackson, of the Meteorological Office.

PROFESSOR J. C. BEATTIE, director of the department of physics of the South African College, Cape Town, and Professor J. T. Morrison, in charge of department of physics at Victoria College, Victoria, South Africa, have returned to their collegiate duties. Since November, 1908, they have been associated with the Carnegie Institution of Washington through the department of terrestrial magnetism, and have now completed successfully magnetic surveys in the regions of southwestern and eastern portions of Africa where magnetic data were most urgently needed. Previous to their association with the Carnegie In-

stitution, they had made magnetic surveys in South Africa with the aid of various grants and had thus gained the requisite experience for the larger task entrusted them by the institution.

At the recent holiday meeting of the Oklahoma State Teachers' Association, those engaged in the teaching of the sciences organized the Oklahoma Academy of Science. Forty-four members were at the initial meeting, but the lists for charter membership will be kept open till March 1. It is expected that the charter membership will not be less than 100. The following officers were elected: *President,* H. H. Lane, Norman; *First Vice-president,* C. E. Sanborn, Stillwater; *Second Vice-president,* D. D. Dunkin, Wilburton; *Secretary,* F. B. Isely, Tonkana; *Assistant Secretary,* D. W. Ohern, Norman; *Treasurer,* H. I. Jones, Muscogee; *Curator,* G. W. Stevens, Alva. At the first meeting several papers were read touching the various lines of investigation in which the workers are engaged. Meetings will be held annually at the Thanksgiving recess.

North Dakota has an Academy of Science organized in 1909. Originally the academy was organized on the basis of the natural sciences, but opinion now prevails that the political and social sciences should be included. The purpose of the academy is to promote cooperation among the workers in the different sciences, to secure more representative support and to improve the several forms of scientific work throughout the state. North Dakota is an enormous empire with a host of unsolved problems waiting for trained workers, especially in the fields of geology, biology and chemistry. The conservation of resources will find a very large place in the work of this academy, notably in the development and utilization of the almost immeasurable supply of lignite coal, valuable pottery and fire clays, and the great undeveloped work of forestation. The rapid growth of towns and the increasing needs for taxation will afford the sciences of sociology and political economy large fields of service. One of the important lines of biological activity which is being pushed by the members of the North Dakota Academy of Science is that of hydrobiology. A helpful ally in this work will be the new biological station which has been established at Devils Lake and is under the direction of the state university. The officers of the academy for the current year are: *President,* M. A. Brannon, of the State University; *Vice-president,* C. B. Waldron, of the State Agricultural College; *Secretary-treasurer,* L. B. McMullen, State Normal School, Valley City.

The third annual meeting and dinner of the Clark University Alumni Association was held in Worcester on Tuesday evening, February 1, the event being a part of the day's festivities in connection with the inauguration of Dr. Edmund C. Sanford as president of Clark College. The meeting was made notable by the celebration of President Stanley Hall's birthday, he being presented with a memorial from his former students in the form of individual letters and a loving cup. The dinner was attended by about 100. It was presided over by Dr. Hermon C. Bumpus, who introduced the following speakers: Dr. Sanford; Dr. Ferry, dean of Williams College; Dr. Thurber, of Ginn & Co.; President Lancaster, of Olivet College. At the business meeting, Dr. W. M. Wheeler, of Harvard University, was elected president and Dr. J. S. French, principal of the Morris Heights School, Providence, R. I., secretary.

The *Journal* of the American Medical Association states that the American Association for the Study and Prevention of Infant Mortality, which was organized recently in New Haven, has established permanent headquarters at the new building of the Medical and Chirurgical Faculty of Maryland, and will institute an active campaign. The section on federal, state and municipal prevention of infant mortality will be under the chairmanship of Dr. William H. Welch, Baltimore; Dr. L. Emmett Holt, New York City, will be chairman of the medical section, and Dr. Helen C. Putnam, Providence, of the section on education. Dr. Hastings H. Hart, New York City, director of the department of child-helping of the Sage Foundation, is chairman of the section on philanthropic prevention and Miss

Gertrude B. Knipp is executive secretary of the association.

THE question of the authenticity of the Kensington rune, which recently has aroused discussion among antiquarians seems to have entered upon a new phase by the announcement that the Minnesota Historical Society has, after a lengthy investigation, given its verdict in favor of the genuineness of the stone, which is dated 1362. The announcement is concurred in by the Scandinavian department of the University of Minnesota and by scientific men at the university who have carried on independently an examination of the stone with reference to language, historical conditions and the evidence of weathering of the stone and the runic lines. The Chicago Historical Society recently had the stone on exhibition, a lecture being delivered in favor of the genuineness of the stone by its owner, Mr. H. R. Holand, which was afterwards discussed by Professor George T. Flom, professor of Scandinavian languages and literature in the University of Illinois, who had been invited by the society to present the results of a philological examination of the inscription of the stone. Professor Flom maintained that the linguistic forms of the inscription are in this case the only scientific test and these are in themselves absolute and conclusive, and he showed by an analysis of the word forms, inflexions, phonology and meanings of certain words, and a presentation of the characteristics of the old Swedish language of the time, that the so-called runestone must be adjudged a fake. Its language is a mixture of nineteenth century Norwegian and Swedish, with a few antiquated words modified further by an evident antiquarian effort in orthography, which, however, the modern rune-master, not possessing a knowledge of old Swedish, fails to harmonize with the orthography and the pronunciation of the time. Professor Starr W. Cutting and Dr. C. N. Gould, of Chicago University, subscribe unreservedly to Professor Flom's views of the language of the stone. An interesting phase of the situation is presented by the fact of the verdict of the Minnesota Historical Society, which has recently bought the stone from the owner for $1,000 and given Mr. Holand a stipend of $2,000 for study in Scandinavian.

FOR some time there has been in contemplation the establishment of an imperial chemical institute at Berlin similar to the *Reichsanstalt*. The *Journal* of the American Medical Association states that the wholesale chemical industry has established an imperial society which decided at its last meeting to appropriate $225,000 for the founding of an imperial chemical institute. As a preliminary the association formulated the demand that the federal government should furnish the ground and that the Prussian department of education should supply a professor from the University of Berlin as president of the institute, and an associate professor as director of one department.

UNIVERSITY AND EDUCATIONAL NEWS

A GIFT of $150,000 for the erection of an administration building and library at the Rensselaer Polytechnic Institute of Troy, N. Y., by the Pittsburgh Alumni Association has been announced.

PROFESSOR W. J. HUSSEY, director of the observatory of the University of Michigan, announces that the university is about to rereceive gifts aggregating $20,000 from Mr. R. P. Lamont, of Chicago, a member of the class of '91. One gift, representing $17,000, is a deed of land directly east of the observatory, bordering upon the arboretum. This should always insure a sky line free from smoke and dust. Mr. Lamont has also furnished funds to start the construction of a 24-inch refracting telescope.

GOVERNOR W. R. STUBBS has given the University of Kansas $1,000 for a fellowship to investigate the extraction of medicinal substances from the glands of deep-sea mammals. The fellowship has been awarded to Roy Wiedlein, who will spend part of the time in Alaska.

AT the ninth annual dinner of the alumni of Stevens Institute, which took place at the Hotel Astor, New York, on February 12, nearly three hundred men cheered President Humphreys when he presented his program for the development of the institute. The other speakers included Dr. H. S. Pritchett,

president of the Carnegie Foundation for the Advancement of Teaching; Col. E. A. Stevens, of Castle Point; Hosea Webster, '82, of the Babcock & Wilcox Boiler Co.; H. M. Brinckerhoff, '90, president of the Alumni Association and electrical associate of Wm. Barclay Parsons; and E. H. Peabody, '90, of the Babcock & Wilcox Co., the toastmaster. President Humphreys announced that he had recently received $63,500 of the $1,250,000 which he expects to raise for the improvement and extension of the institute. This money is to be used for the purchase of the Castle Point estate, for the erection of several buildings, including a dormitory, a mechanical laboratory and an electrical laboratory, and to provide an adequate endowment fund.

THE Minnseota *Alumni Weekly* states that President A. Ross Hill, of the University of Missouri, has notified the authorities of the University of Minnesota that he could not consider an offer of the presidency of the university.

R. D. THOMSON, a graduate of Harvard University in the class of 1907, has been appointed instructor in electrical engineering in the University of Vermont.

DR. H. IRVING ELESHINGER, associate in chemistry at the University of Chicago, has been appointed professor in the University of Pekin. Professor Oscar Eckstein, formerly instructor in chemistry in the University of Chicago, is director of the department of science.

MR. A. J. HEBERTSON, reader in geography at Oxford University, has been appointed to a professorship of geography.

MR. A. C. SEWARD, professor of botany at Cambridge University and a former fellow of St. John's College, has been elected to the professorial fellowship vacated by Mr. Bateson's resignation of the professorship of biology. Mr. Bateson has been made honorary fellow of the college.

AT Oxford University Dr. Walter Ramsden, fellow of Pembroke; Dr. H. M. Vernon, fellow of Magdalen, and Mr. S. G. Scott, B.M., Magdalen, have been appointed demonstrators in physiology.

DISCUSSION AND CORRESPONDENCE

ON THE SO-CALLED NORWOOD "METEORITE"

THE issue of SCIENCE for January 28 contains an article by Professor Frank W. Very entitled "Fall of a Meteorite in Norwood, Massachusetts," descriptive of what he supposes to have been a meteoritic stone said to have fallen on the farm of Mr. W. P. Nickerson, of Norwood, Mass., during the night between October 7–8, 1909. On account of the specific character of the description and for fear that this may be successful in giving the "Norwood meteorite" a place in the literature, I feel that another opinion with regard to the character of the specimen should be placed on record.

I saw the newspaper account of this fall directly after its occurrence, and after correspondence with Mr. Nickerson took the first opportunity that presented itself to examine the specimen, which was then on exhibition in a "dime museum" in Boston. Mr. Nickerson himself met me there and showed me the stone. Professor Very's account of the appearance of the mass is sufficiently accurate, but his interpretation of it is entirely erroneous. As a matter of fact, the specimen is a characteristic glacial bowlder of a basic igneous dike rock, the matrix in which has been weathered so as to leave the characteristic large phenocrysts of plagioclase projecting from the surface. There is no surface indication whatever of flowage or of the skin which is characteristic of freshly fallen stony meteorites. I broke off a piece of the stone and examined the fresh fracture with the greatest care under a hand lens without finding any indication of the existence of metallic iron in the mass. Since reading Professor Very's article, I have had a thin section of my fragment made. Microscopic examination of this proves the rock to be ordinary labradorite-porphyry—a diagnosis which has been confirmed by Dr. H. S. Washington, who has called my attention to his description of this rock type from Essex County, Mass.[1]

Mr. Nickerson told me about the broken bars of the gateway under which the mass was

[1] *Journal of Geology*, Vol. 7, p. 290, 1899.

found and the other circumstances as related by Professor Very, but he added a statement with regard to a bright flash of light which he had noticed in the sky during the evening of October 7. His description, however, was only that of an unusually brilliant shooting star. A meteorite of the size of this specimen would surely have illuminated the region over many square miles with almost the light of day, judging from the reports of known meteorites which have been seen to fall, but no such occurrence was reported from Norwood. If the falling of a meteorite was the cause of the broken bars, the mass has not yet been found, or at any rate it was other than the specimen described by Professor Very and seen by me.

The circumstantial nature of the observations made by the several persons who had to do with digging up the "meteorite," as quoted in the article to which reference is made, are not as conclusive to me as they are to Professor Very, through scepticism engendered by the falsity of nearly all of the many reports that have come to my office during the past sixteen years in which people have described "meteorites" that they "had actually seen fall" at their feet or on the lawn in front of their houses, or in the road, or in some other very near-by place. On request, samples of some of these "meteorites" have been sent in, one of them proving to be a piece of fossiliferous limestone, another a bit of furnace slag, another a glacial bowlder of trap rock, another a glazed stone that had been used in the wall of a limekiln, another a glacial bowlder of quartzite covered with a film of limonite. The list might be extended almost indefinitely, but it is not worth while. In almost every case mentioned, the mass when found "was so hot that one could not bear his hand on it."

Edmund Otis Hovey
American Museum of Natural History

A WORD OF EXPLANATION

To the Editor of Science: May I trespass on your space for a word of explanation? A series of public lectures on human sense-organs recently delivered by me in Boston has given occasion to a number of newspaper reports. Most of these reports are entirely erroneous and misleading. None of them have been published with my sanction, but, on the contrary, quite against my wish. I am therefore not responsible for either their form or content.

G. H. Parker

QUOTATIONS

THE SERVICE PENSION OF THE CARNEGIE FOUNDATION

An official action taken two months ago, but only now publicly announced, by the Carnegie Foundation for the Advancement of Teaching seems to have certain ethical aspects that deserve consideration, not only from members of the teaching profession, but also from the public at large. Those aspects will, I think, become sufficiently apparent from a brief recital of the facts in the matter.

Upon its incorporation in 1906 the foundation announced that it would grant retiring allowances to teachers in accepted institutions upon two grounds—old age and length of service. The conditions relating to the old-age pension are not relevant to the present communication. The rule relating to service pensions reads as follows: "Any person who has had a service of twenty-five years as a professor, and who is at the time a professor in an accepted institution, shall be entitled to a retiring allowance"—computed in a specified manner. Between April, 1906, and November, 1909, many university teachers and many governing boards based definite plans and actions of their own upon the supposition that, so far as its resources extended, the Carnegie Foundation would do what it had announced that it would do. The expectation of a service pension was, in some cases, named among the inducements offered men who received calls to institutions upon the "accepted list" of the foundation; it was in other cases a motive for the refusal of otherwise advantageous calls to institutions not upon the foundation. In instances either known or reported to me, teachers nearing the time of eligibility for a service pension have in a great variety of ways altered their plans,

modified their domestic arrangements, made personal sacrifices, in order that, with the aid of the pension, they might be able to retire and carry through without distraction some project of study or of literary production. Some, expecting an early relief from all teaching duties, have foregone leaves of absence which they might have claimed; some have taught in summer schools or night schools who would not otherwise have done so; some have made investments or taken insurance with express reference to the time of their prospective retirement. After institutions, families and individuals have thus, for nearly four years, been permitted and encouraged by the Carnegie Foundation to be vitally influenced in the conduct of their affairs by an expectation based upon the foundation's explicit announcement, the entire system of service pensions is now abruptly abolished, "except in the case of disability unfitting" the applicant "for work as a teacher as shown by medical examination"—which, of course, is purely a disability pension.

The question whether the scheme of service pensions for professors under sixty-five and in good health was originally a wise one I do not here discuss; it is a question of policy concerning which a good deal might be said on either side. But two considerations in the matter seem so plain as to afford no ground for differences of opinion. One is that, unless the Carnegie Foundation is to be guilty of an act of bad faith it should promptly supplement its recent action by the proviso that at least all persons within ten years of the time of eligibility for a service pension, under the old rule, may still claim such pension when their time comes around. The other patent fact is that, unless so supplemented, the latest action of the foundation must hereafter render impossible any confidence in the stability of policy of that corporation. In the federal act of incorporation by which the foundation received legal entity two classes of prospective beneficiaries are specifically distinguished and equally emphasized: college teachers "who by reason of long and meritorious service *or* by reason of old age, disability, or other sufficient reason" shall be deemed entitled to pensions. The service-pension feature has similarly been especially emphasized in the public reports and explanations of policy of the president of the foundation. A body which at a moment's notice abandons one of the two purposes constituting its proclaimed *raison d'être* is equally likely to modify the other to any assignable degree.

I can scarcely suppose that any one will think it relevant to note that the foundation has always retained the power to alter its rules "in such a manner as experience may indicate as desirable." All public bodies, doubtless, have such power to amend their regulations; but it is not commonly conceived that the power can justly be exercised in such a way as to have a retroactive effect, or to nullify equities acquired or expectations reasonably aroused by virtue of the previous regulations.—Arthur O. Lovejoy in *The Nation.*

THE PRINCETON GRADUATE COLLEGE

YESTERDAY'S decision by the Princeton trustees seems to have met the question immediately at issue in a way both happy and just. Few details are as yet published, but the main points are clear. Two gifts for the endowment of a graduate college had been offered, one apparently conditioned upon a site on or near the campus, the other contemplating a location at a distance from it. There were also questions about the control of the new institution by the academic governing body of the university. Because it was found impossible to unite the two foundations, or otherwise to reconcile the differences about administration, the larger gift was withdrawn. While regretting this, and hoping that an adjustment may yet be found, the trustees distinctly uphold President Wilson. He was right, they decide, in insisting upon a proper university control of the proposed graduate college, and upon its being absorbed into the common academic life at Princeton. Yet they distinctly refer to "dissensions" in the faculty and in the governing board which it will be the duty of the trustees to grapple with in the near future. Thus the particular dispute

is seen to be merged in the larger and general question.

What that is at Princeton, it is perfectly well known. President Wilson has left his attitude in no doubt. He is for the freest and fullest play of the democratic spirit in colleges, and as a means of securing it at Princeton urged the system of dormitories in which all the students should live. This involved the abolition of the expensive and exclusive clubs which have been so marked a feature of life at Princeton. But though the faculty approved a proposal which many considered revolutionary, the trustees have thus far declined to give their assent to it. This is clearly the question about which the "dissensions" have sprung up, involving as is known a great deal of bitter feeling with rumors that President Wilson would be forced to resign.—New York *Evening Post.*

An attitude was taken towards Mr. Proctor's generosity in regard to Princeton's long-professed hope, he was catechized in such a manner in regard to what he was attempting with commendable forbearance to do for his Alma Mater, that, as Mr. Pyne said in the statement he felt it necessary to make public, "From the start his generosity has met with such an extraordinary reception, his motives have been so misconstrued, his patience has been so sorely tried that self-respect has at last demanded the withdrawal of his princely gift. Thus at least $900,000 has been lost to Princeton by the treatment he has received."

The recent meeting of the Board of Trustees closed one act of this remarkable drama —with an anti-climax. It has by no means settled the matter. We have merely lost a Graduate College, with very little chance now of getting one. But the controversy over the issues raised seems only to have begun. The object of the recent meeting of the board was to call a truce. . . . To state, therefore, as most of the newspapers did, that Mr. Pyne and the other members of the board who were not in accord with the treatment by the Committee of Five of Mr. Proctor's offer were won over from their position is about as far from the truth as it could be. They stand exactly where they stood before, only more staunchly so, more indignantly so, and have expressed the desire to have this clearly recognized. —Jesse Lynch Williams in *The Princeton Alumni Weekly.*

SCIENTIFIC BOOKS

New Manual of Botany of the Central Rocky Mountains (Vascular Plants). By John M. Coulter. Revised by Aven Nelson. New York, American Book Company. January, 1910.

When the present reviewer landed in America, in 1887, his first purchase was a copy of Coulter's "Manual of Rocky Mountain Botany," at that time rather recently published. In his subsequent wanderings over the state of Colorado, this volume was his inseparable companion, proving itself a most serviceable hand-book to the flora of the region. In those days it was innocently supposed that the Rocky Mountain flora had been nearly all described, and if a plant did not altogether agree with any of the descriptions, it was generally assumed that the species must be variable. It was not possible for the worker in the field to discover that numerous species, supposed to be identical with those of distant regions, were in reality quite distinct.

About the year 1894 there began a new era in the study of Rocky Mountain plants. The material in the herbaria was scrutinized anew, and many collections were made in different parts of Montana, Wyoming and Colorado. Presently new species began to be described, and new generic names proposed. The activity increased until the output was astonishing, and this has continued down to the present time. The old manual no longer represented the knowledge of the day, and a new edition was planned. This was placed in the hands of Professor Aven Nelson, of the University of Wyoming, who has been a much larger contributor to the knowledge of Rocky Mountain plants than all the other residents of that region combined. The appearance of the new book was looked forward to with extreme interest and impatience by students of this flora, and now that it is out, many are the discus-

sions and investigations it is stimulating. The author, as we learn from a private letter, does not for a moment consider that he has said the final word on the subject, but hopes that this presentation of his results up to date will prove of service, and especially will cause others to study the subject in the field, and gradually put it on a firmer basis. In this he is wholly justified, and whatever we may think about particular disputed matters, we must recognize that he has done an immense service, in the first place by his researches, and in the second by presenting them in a compact and convenient form, so that all may make use of them. No one, in future, will pretend to study the plants of Colorado or Wyoming without a copy of Nelson's "Manual" by his side.

I have had the curiosity to count the number of species admitted as valid in the new manual, which were undescribed at the time of publication of the first edition, in 1885. The number is 787, about 28 per cent. of the whole flora. This count includes all specific names first published since 1885, but does not include varietal names proposed prior to that date, and given specific standing later. Of the 787, no less than 244 were proposed by Professor Aven Nelson himself; 152 are by Dr. Rydberg, of the New York Botanical Garden and 148 by Dr. E. L. Greene, now of the U. S. National Museum, but at one time a resident of Colorado. The other authors are as follows: Elias Nelson, 20; Jones (of Utah), 18; Scribner (grasses), 17; Vasey, 15; Coulter and Rose (Umbelliferæ), 15; Bailey (mainly *Carex*), 13; Osterhout (of Colorado), 12; Small, 11; Eastwood (formerly of Colorado), 10; Britton, 10; Wooton (of New Mexico), Nash and Sheldon, each 5; Goodding (of Wyoming), Trelease and K. Schumann (Cactaceæ), each 4; Sargent, J. G. Smith, Bicknell, Piper and Porter, each 3; A. S. Hitchcock, Beal, Vasey and Scribner, O. Kuntze, Howell, Robinson, Ramaley, Blankinship (of Montana), Henderson and Leiberg, two each; Underwood, Maxon, D. C. Eaton, Macoun, Nash and Rydberg, Scribner and Williams, Holm, Fernald, Bebb, Ball, Coulter and Fisher, Canby and Rose, Pax, Huth, Cockerell, Vail, Eaton, Coulter, Wiegand, Holzinger, Nelson and Cockerell, Mackenzie, Pammel, E. G. Baker, Léveillé, Coulter and Evans, Wight and Wright, one each.

Thus the three principal workers have contributed 544 between them, 65 have been published by miscellaneous residents of the region covered by the manual, 168 by American botanists not resident in the Rocky Mountains and ten by European botanists.

After all this, the reader may be astonished to learn that Nelson's work is planned on what are called "conservative" lines, *i. e.*, those of *not* conserving the names of "critical" or doubtful species. The number of species accepted as valid is 2,733, while no less than 1,788 specific names are rejected as synonyms or insufficiently known. Many of those latter were proposed by Professor Nelson himself, more by Rydberg and Greene. In addition to the large number rejected, very many are not mentioned at all, presumably because the author did not possess specimens. Most of these latter are "critical" forms, but by no means all. Thus *Woodsia mexicana*, for which Rydberg cites five Colorado localities, is absolutely ignored, and there are many instances only a little less striking. It is stated in the preface that the flora includes the northern half of New Mexico, but we miss not only the rarer endemic plants of that region, but many of the commonest roadside flowers, such as *Sphæralcea fendleri*, *Commelina dianthifolia* and *Cosmos*. On the other hand we find a few species of southern New Mexico, as *Rosa stellata* and *Polemonium pterospermum*.

Rydberg, in his recent (1906) "Flora of Colorado," recognized 2,912 species, a number somewhat greater than Nelson admits for his much larger area. As is well known, Rydberg treats many of the minor or critical forms as full species, which of course accounts for the difference. The quite recent (1909) French edition of Schinz and Keller's "Flora of Switzerland" includes 2,534 species of vascular plants. When we consider the much smaller area of Switzerland, and the greater variety and distinctness of the life-

zones in the Rocky Mountains, it would seem that the latter might be expected to have twice as many species. Switzerland has, of course, been more thoroughly investigated, but the large number of species given is not due to the inclusion of the "critical" forms, for the authors tell us in the preface that these are all to be given separately in a subsequent volume, the "Flore Critique." In the 1909 volume the species are supposed to be such in the ordinary sense, and a special mark is appended to those (and they are very numerous) of which segregates are known, the account of these being promised in the later work.

There is no doubt that the separation of the ordinary from the "critical" flora, after the manner of Schinz and Keller, is convenient to the numerous class of botanists who are not specialists in taxonomy. Professor Nelson's work corresponds to the Swiss volume before me while Dr. Rydberg's book on the plants of the same region, expected in about a year, will really be a "Flore Critique," at least to a considerable extent. American workers are at present roughly divided into two groups, of which a modern European botanist would say that one failed to discriminate the lesser types, many of which are of the highest interest from a biological standpoint, while the other, recognizing minor segregates, treated them all as species, without any attempt to indicate in the nomenclature their various kinds and degrees of relationship to the species of the older school. We venture to hope and believe that at length a middle ground will be found in a system of classification more like that of advanced European workers, which permits the presentation of the most minute details, without seriously disturbing the current conception of species.

T. D. A. COCKERELL

Umwelt und Innenwelt der Tiere. Von J. VON UEXKÜLL, Dr. med. hon. c. Berlin. Verlag von Julius Springer. 1909. 8vo, pp. 259.

The bold and original investigations of von Uexküll have culminated in his "Umwelt und Innenwelt der Tiere"; culminated, not because there are reasons to suppose that this will be his last contribution to science, or perhaps even his best, but because he has synthesized into a coherent whole the results of earlier work, and with the addition of fresh materials, and maturer judgments, has sketched in the outlines of a reformed biology.

Large sections of the book must be left to those who have made certain protozoa, cœlenterates, annelids, molluscs, crustaceans and insects, subjects of prolonged study, yet as a whole, the work should appeal to every biologist, no matter what group of animals or facts he knows best. It is these matters of general appeal that concern us.

First of all, a living thing is neither a bundle of anatomical details nor a collection of physiological processes, nor both of these together, for things that live, live in an environment. To cultivate either anatomy or physiology exclusively is as futile as the study of environments with all the animals left out, for the business of the biologist is to know, not merely structure or function, but what the vital machinery is, how it works and the circumstances under which the work is done.

The organism, von Uexküll teaches, must be studied, not as a congeries of anatomical or physiological abstractions, but as a piece of machinery, at work among external conditions. Our analyses, so far, have been by no means exhaustive, for we have largely neglected the fact that the organism makes its surroundings. It is true that environment includes the sum total of everything outside the individual, and, within these limits, is the same for all living things. Yet this is wholly misleading, for environment is both essential and unessential, and only the former counts practically in the shaping of biological destinies. The shark, the jellyfish and the pluteus, that swim side by side at the base of a wharf-pile, under uniform conditions of salinity, temperature, light and mechanical agitation, have each a different effective environment, and to this extent live in different worlds. Only when the receptors, through which external conditions make their appeal, are alike, are the outside conditions similar, but as the stimulated organs vary, so do the

several environments. Even within the same group these differ.

One need but glance at the pictures of Holbein to realize that the world in which he lived was far richer than our own. The simplest things are endowed by him with a reality that makes the objects we see pale.

The embryologist who has reared the eggs of the oyster, the starfish and the sea-urchin, within the same tumbler of sea-water, each into its proper larva, can testify strongly in favor of von Uexküll's view. Nevertheless, it does not follow that the organism which by selection makes its environment, is the all-important thing. Our author himself does not contend that it is, but there are those who do. It may not be amiss, therefore, to point out that an animal adapted to an environment of which factors A, B, C and D, constitute the practical portion, may be transferred suddenly to surroundings in which A is represented by $A+1$; B by $B+1$; C by $C+1$; and D by $D+2$. If $A+1$ can serve for A, the substitution is made, and similarly $B+1$ and $C+1$, may take the places, respectively, of B and C. On the other hand, $D+2$ may be beyond the range of the organism unless introduced to it, through the medium of $A+1$, $B+1$ and $C+1$. If under these conditions $D+2$ is selected, it follows that the new environment has made the animal over, and von Uexküll's dictum, therefore, can be enlarged to read, The organism makes the environment, and, reciprocally, the environment makes the organism.

The discussion of the environment leads by a natural step to a subject sadly in need of sunshine and fresh air.

Dictionaries define "organization" as "specifically the constitution of an animal or vegetable body, or of one of its parts," and many biologists use the word in this sense. Were they consistent, no one would object, or be the worse for the substitution of "organization" for "structure," but the word is as versatile as the men who use it, and the synonym transforms before our eyes into a brief formula for that unity in action which comes with transcendent complexity. Not only this, but many, gifted with the power of making things more difficult than they really are, would have us believe that the organization is inside the thing organized!

The discovery that organized things come from eggs has led us to look in eggs for the method of origin. The creatures that come from eggs, however, are organized, not because they have a particular structure, or form, but because the parts that compose them are wonderfully related. One of the most beautiful examples of organization in nature is the bee-hive, a thing marvelously related to its environment, and hardly less marvelous abstractly, for its members act not only for their own welfare, but especially for that of the community and the race. It would be futile to study serial sections for this organization, since only honey, wax and the fragments of bees would greet the investigator's eyes. No less futile is the search in eggs, for organization is not a material thing, but the sum of the interrelations between material things. From this standpoint, reversals of polarity or symmetry are in the same category with the evolutions of a company of soldiers, and, like the orderly facing about of a well-drilled body of infantry, are possible only under conditions dependent on structure, yet themselves not structural. Physiological interrelations do not exist in space. As well try to dissect the digestion out of the duodenum, as to search with anatomical methods for organization, in this sense, in the egg!

If the point of view presented seems wholesome, the impetus so gained, in favor of von Uexküll's opinions, is nevertheless insufficient to carry us over the vitalistic bumper which he has thrown across the biological roadway. The argument is this: Living things are machines, but they are not all machinery. The hand and foot, the arm and leg, the stomach and heart, are machines, but they come from the egg, and the power to differentiate machines is itself super-mechanical. Reproduction, regeneration and certain kinds of regulation, occur in no machines known to man, and hence any machines that reproduce, regenerate or regulate are to this extent "übermaschinelle."

The logical weakness of this argument is at once supported by the circumstance that the protoplasm which differentiates the machinery is a liquid, and as all stresses and strains in a fluid are instantly equalized, liquid machines are physical impossibilities. The protoplasm of the egg is, therefore, no machine, and is forever beyond the reach of mechanical investigations. Physiology, anatomy, chemistry and physics are all powerless to grapple with this problem. The essence of a living thing is that it is vital, and this attribute, if accessible to the human intellect at all, can be understood only by the aid of "reine Erkennungslehre."

Whether vitalism will triumph ultimately, is one of the many things that most biologists do not know, although von Uexküll considers victory inevitable. Lack of philosophical insight is held responsible for the bankrupt condition of our science, but however this may be, to restore confidence in biological currency by means of an inflation of vitalistic values seems a doubtful undertaking even if liquid machines are impossible. But is protoplasm a liquid?

The naked amœbæ are the most fluid of all animals, nevertheless their outer layers are visibly different from the interior, and there is every reason to believe that the ectosarc subserves many of the functions performed by the firmer boundaries of other cells. Among these functions is that of being a barrier which prevents the animal from becoming infinitely diluted in the medium in which it lives. Furthermore, the ectosarc, like the cell membrane, allows certain substances to pass in and out, and in this way insures differences in chemical composition between the amœba and its surroundings, while at other times it is the gate through which the equalization of differences is brought about. As long as protoplasm does not exist abstractly, but always occurs in nature behind a barrier that makes possible interrelations with the environment, and prevents fusion and identity with it, arguments based on a liquid as it isn't, can have no bearing on the case of vitalism *vs.* mechanism.

We will suppose, however, that the optical differences between the ectosarc and the endosarc are illusory; that the outer layers of the most fluid of all amœbæ are not physiologically the equivalents of cell-membranes; and finally that we are in reality dealing with liquids entirely uniform. We will endow these microscopic Frankensteins with life. Are they machines?

Abstractly—no; concretely—yes, for our imaginary creatures exist in an environment, and interaction between the two is the one condition under which life is possible. As long as such interaction occurs, as long as metabolism takes place, we have differences of potential, stresses and strains; as long as anything happens, and life is a happening, we have a mechanism, a machine, but the machinery is neither the amœba nor the environment, but the two together. Von Uexküll's own contention that an organism devoid of environment is an absurdity, harmonizes so completely with this criticism, that it is difficult to see how the road which he has traveled could ever have led him into the vitalistic man-trap.

To make a good book, however, does not require infallibility. Thought, honesty and clearness are the necessary ingredients, and a writer who commands these fertilizes the minds of his readers, and where wrong, furnishes the materials for the correction of his own mistakes. Even though von Uexküll seems to have failed in some of his undertakings, he is nevertheless an author thoroughly worthy to be read.

OTTO C. GLASER
UNIVERSITY OF MICHIGAN

Handbuch der Klimatologie. Band II., Klimatographie. I. Teil, Klima der Tropenzone. Dritte, wesentlich umgearbeitete und vermehrte Auflage. Von Dr. JULIUS HANN. 8vo, pp. x + 426, figs. 7. Stuttgart, J. Engelhorn. 1910. Preis 14 M.

The first part of the second volume of the third edition of Hann's monumental work—revised, enlarged, up to date—the unique storehouse of climatological fact and description; the indispensable reference book for all who

deal in any way with the science of the earth's atmosphere; a book which has laid the whole scientific world under a debt of gratitude to its author, impossible to overestimate.

R. DeC. Ward

SPECIAL ARTICLES

EARTH MOVEMENTS AT LAKE VICTORIA IN CENTRAL EAST AFRICA

The profound significance for Central East Africa of the fall of Omdurman in 1898 has been strikingly brought out by subsequent scientific publications of the Egyptian Survey Department. Captain H. G. Lyons, late the eminent director general of that department, and now occupying the newly established chair of geography at the University of Glasgow, published in 1906 an extended monograph upon the Nile River and basin.[1] This volume, which is issued by the finance ministry, compels admiration as much by its exhaustiveness as by its orderly arrangement and lucid presentation of the facts. Through setting forth in a well-digested summary the scientific results secured by early and late explorers and scientific travelers, and by including a full bibliography of the geography and geology of the district, the work has been made authoritative and indispensable.

Those who have not already interested themselves in the region will be surprised to learn how many observing stations supplied with water gauges, have been established upon the Upper Nile and its tributaries, and of the almost continuous series of careful gauge readings extending over a full decade.

The very interesting conclusions on the basis of these readings, which were foreshadowed in the monograph above cited, are contained in a very recent report of the Survey Department.[2] The conclusion to which Captain Lyons is forced is that the gauges have registered oscillations of level of the ground about Lake Victoria. Upon the northern and northeastern shores of this lake three gauges were established—one at Entebbe on the northwest shore, another at Jinja on the north shore where the Nile leaves the lake, and one at the head at Kavirondo Gulf near the railway terminus on the northeast shore. Although all three gauges have been moved since they were first established, and though there are some gaps in the records, yet in the main it is true that daily gauge readings are available from three widely separated stations since September 30, 1898.

Study of the monthly averages of these readings has shown with much probability that in October, 1898, a sinking of the land at Entebbe began and continued during 1899. It was most marked during August and October of that year. At the end of 1900 and during the early months of 1901, a slight elevation seems to have occurred, though in May and June following a renewed sinking took place. This movement on the northwest shore of the lake seems not to have been participated in by the land farther to the eastward. These local movements, extending as they do over several months, can not be explained by wind effects.

From November, 1901, to February, 1902, the Jinja gauge curve was on the whole rising, while those at Entebbe and Kisumu were falling steadily. Again in December, 1902, the Jinja curve was steady, while those of Entebbe and Kisumu were rising, but in February, 1903, the case was reversed. Subsequent to these later dates the gauges have shown no noticeable discrepancies which could be attributed to a recurrence of oscillations of level until in 1908, when at Jinja the lake level fell 14 inches between February 5 and 19, the change of level at each of the other two stations being only an inch and a half.

To quote Captain Lyons, all the available information "points to the frequent and recent differential movement of great blocks of the country." Following Herrmann he states:

> The movements of upheaval have acted along NNE–SSW directions, and the intensity seems to

[1] "The Physiography of the Nile River and its Basin," Cairo, National Printing Department, 1906, pp. 411 and numerous maps.

[2] "The Rains of the Nile Basin and the Nile Flood of 1908," by Captain H. G. Lyons, F.R.S., Survey Department Paper No. 14, Cairo, 1909, pp. 69, pls. 8.

have been most marked in the southwestern part of the area, not far from the Virunga group of volcanoes of Lake Kivu. Five main blocks may be recognized which are separated by troughs; the islands of the western coast of the Victoria Lake present the first of these, while three others range one behind the other between the lake shore and Valley of the Kagera, and in the intervening troughs lie lakes, swamps or slowly flowing rivers; the fifth forms the Ruanda Plateau west of the Kagera. The edges of these blocks have as yet been but little modified by weathering, so that the latest movements would appear to be comparatively recent.

The formation of Victoria Lake is shown to be due to mutual adjustments among these earth blocks, separated as they are by great faults running in the directions N.–S., E.–W., NE.–SW., and in the area south of the lake also NW.–SE. Again quoting Lyons:

> Large masses, many kilometers long, have been raised, lowered or tilted, and in the valleys formed along the fracture lines, the main drainage lines of the district run. Lake Victoria itself is outlined by such fractures.

All writers seem to agree upon the dominance of block movements of the crust in determining the relief of Central East Africa, and it is therefore interesting to learn from these newer studies of the Nile Basin, that the great river itself between Korusko and Aswan (Assouan) wherever crystalline rocks occur in its neighborhood, takes directions parallel to the neighboring intrusive dikes.

While the region is one of earthquakes, the movements disclosed by the series of gauge readings would seem to be of the slower type, and it would be of great interest to know whether the main periods of change of level correspond in time to any subterranean rumblings such as are now being reported from so many unstable districts and are called *brontidi*. As compared with the crustal movements which are revealed by gauge readings within the Laurentian Lake district of North America, these African observations differ in being more rapid, and, further, in indicating reversals in the direction of movement. They similarly, however, point the moral that the sensitiveness of great inland bodies of water, when employed as precise levelling instruments, has never been properly appreciated.

Wm. H. Hobbs
University of Michigan,
Ann Arbor,
January 29, 1910

THE FORTY-FIRST GENERAL MEETING OF THE AMERICAN CHEMICAL SOCIETY. II

DIVISION OF FERTILIZER CHEMISTRY

F. B. Carpenter, *Chairman*
J. E. Breckenridge, *Secretary*

The Direct Estimation of all Intensities of Hydrogen Ion Concentration by Means of Di-nitrohydrochinone: Lawrence J. Henderson.

The Nitrogen Thermometer from Zinc to Palladium: A. L. Day and R. B. Sosman.

Laboratory Methods for Organic Nitrogen Availability: C. H. Jones.

The alkaline permanganate and pepsin methods for determining organic nitrogen availability as used in the Vermont Experiment Station laboratory are described. Results by these methods on fifty-one high- and low-grade animal and vegetable ammoniates now on the market are tabulated and briefly commented upon.

Both methods have been used at the Vermont Station on officially collected commercial fertilizers for the past twelve years. Tables were shown giving the results of this work.

The writer concludes that the alkaline permanganate method, while empirical, is nevertheless valuable to eliminate quickly from a large number of samples those of questionable availability which may then be tested by the longer pepsin process and qualitatively to show more in detail the nature of the nitrogen source.

The following papers are reported by title:

Influence of Chemistry on Agriculture: F. B. Carpenter. (Chairman's address.)

Concerning After Effects of Certain Phosphates on Limed and Unlimed Lands: H. J. Wheeler.

New Method for Filtrating Insoluble Phosphoric Acid: R. H. Fash.

Facts Brought Out Regarding Uniform Analytical Methods for Phosphate Rock through the Recent Work of the National Fertilizer Association's Committee: C. F. Hagedorn.

Neutralization of the Ammonium Citrate Solution: J. M. McCandless.

Note on the Determination of Phosphoric Acid by the Official Volumetric Method: F. B. Carpenter.

The Improvement of Analytical Processes: W. D. Richardson.

The Cost of Available Nitrogen in Commercial Fertilizers: E. B. Voorhees.

Bacteriological Methods for Determining the Available Nitrogen in Fertilizers: J. G. Lipman.

Notes on the Recovery of Waste Platinum: A. W. Blair.

Method and Materials used in Soil Tests: H. A. Huston.

Accuracy in Taking and Preparing Mixed Fertilizer Samples: F. B. Porter.

The Determination of Inferior Ammoniates in Commercial Fertilizers: John P. Street.

Reports of Committees: Paul Rudnick, for the Committee on Nitrogen; G. A. Farnham, for the Committee on Phosphoric Acid; J. E. Breckenridge, for the Committee on Potash; F. B. Veitch, for the Committee on Iron and Aluminum.

DIVISION OF AGRICULTURAL AND FOOD CHEMISTRY

W. D. Bigelow, *Chairman*

W. D. B. Penniman, *Secretary*

Analyses of Maize Products: Edward Gudeman.

Analyses of maize products during the last five years, showing changes in composition of these products, especially as to ash, acidity, sulphites, arsenic and metallic impurities. Discussion of the effect of federal and state food acts on the composition of these products.

The Influence of Microorganisms upon the Quality of Maple Syrup: H. A. Edson.

Studies upon the microscopic flora of maple sap during the past three years have shown that the sap within the vascular bundles of the tree is free from microscopic organisms, but that the tap hole, spout and bucket afford favorable lodging places for the development of microscopic life. With the advance of the season as the days become warmer and the freezing nights less frequent and less severe, yeasts, mould spores and bacteria appear in the sap in increasingly great numbers. By isolation and inoculation experiments specific groups of organisms have been shown to be the cause of the various types of abnormal sap characteristic of the late runs, such as green, red, milky and stringy sap. Inoculations with pure cultures in first run material yield syrup of inferior color and flavor such as is frequently produced from the last run.

Sap of the last run when drawn under conditions to exclude heavy inoculations with microorganisms yields syrup of superior color and flavor which is in striking contrast to that produced from sap drawn in the usual manner from the same tree at the same time.

Analyses and Composition of Milk and its Products: Edward Gudeman.

Analyses of milks from different localities and at different seasons. Discussion of change of ratio between fat and solids not fat, and influence on composition of concentrated milk products, evaporated and condensed milks and milk powders. Influence of heating milks of various composition during pasteurization, sterilization and concentration.

The Composition of Milk: Hermann C. Lythgoe.

Analyses of known purity samples of milk show that the milk sugar is practically constant while the other constituents are variable. This fact may be used in detecting skimming as well as watering. After making the fat and total solids determinations the proteids may be calculated from either by Van Slyke's or Olson's formulæ, respectively. If the milk has been skimmed the calculated proteids will be too low and if the sugar is calculated by difference (assuming an ash content of 0.7 per cent.) it will be too high. Experience has shown that these calculated figures for milk sugar vary between 4.2 per cent. and 4.8 per cent. in pure milk. If the milk has been watered they will be low, while if the samples have been skimmed the calculated sugar will be high.

Some Applications of Electricity to Apparatus and Laboratories for Water Analysis: Ellen H. Richards.

The advantage of using electricity as a source of heat for making distillations, evaporations and running ovens and incubators is pointed out. The tungsten lamp is useful as a uniform source of light for color determinations. Electricity makes possible the use of the ventilating fan and the vacuum cleaner.

It is estimated that electricity is economical for laboratory uses if it can be had at a cost of four cents per kilowatt hour. The cost may be reduced to this figure by any establishment using exhaust steam for heating.

It is so great a saving of labor and adds so much to the general efficiency of the laboratory and accuracy of its results, that it can not be considered dear at twice that cost.

Pentosans in Soil: Oswald Schreiner and Edmund C. Shorey.

Nearly all soils when treated with boiling 12

per cent. hydrochloric acid yield some furfurol, indicating the presence of some pentosan body.

Ten soils containing widely different amounts of organic matter (organic carbon from 0.31 to 27.1 per cent.), were subjected to the official method for the determination of pentosans and figures were obtained which varied from 0.005 to 0.275 per cent. No relation between the total carbon and pentosan carbon was apparent, the soil containing 27.1 per cent. organic carbon yielded 0.109 per cent. pentosan, while a soil containing 6.99 per cent. organic carbon yielded 0.275 per cent. pentosan. From this latter soil there was obtained by precipitating a sodium hydrate extract with alcohol a dark-colored, gummy precipitate which yielded a pentose sugar on hydrolysis with acid. An osozone obtained from a solution of this sugar had a melting point of 161° C., and the solution yielded a small amount of the characteristic crystals of the compound of xylose with cadmium.

The following papers are reported by title:

Relationship between Bacteriological and Chemical Findings in the Examination of Milk, Water and Food Products: S. C. PRESCOTT.

Microscopical Examination of Spices and Food Products: A. L. WINTON.

The Determination of Cane Sugar by the Use of Invertase: C. S. HUDSON.

Sampling of Sugar: C. A. BROWNE.

The Composition of Canned Peas and Lima Beans: W. L. DUBOIS.

Composition of Cold Water Extracts of Beef: P. F. TROWBRIDGE and C. R. MOULTON.

Phosphorus in Flesh: P. F. TROWBRIDGE.

The Cold Storage of Apple Cider: H. C. GORE.

The Value of Peaches as Vinegar Stock: H. C. GORE.

The Composition of Vinegars formed from the Ciders of Different Varieties of Apples: H. C. GORE and ALICE L. DAVISON.

The Examination of Vinegar: R. W. BALCOM.

The Estimation of Glycerine in Meat Preparations: F. C. COOK.

A Comparison of Meat and Yeast Extracts of Known Origin: F. C. COOK.

The Working Efficiency of a Constant Temperature Laboratory for Polarizing Sugars: C. A. BROWNE.

The Separation of Colloids from Solution by Freezing and some Practical Results: W. D. RICHARDSON.

The Use of the Refractometer in Detecting Added Water in Milk: P. H. SMITH and J. C. REED.

The Stability of Butter Fat: E. B. HOLLAND.

The Influence of the Method of Drying on the Non-volatile Ether Extract of Spices: A. LOWENSTEIN and W. P. DUNNE.

Sampling of Ground Spices: HARRY E. SINDALL.

Delicacy of the Ferric-chloride and Jorrissen Reaction for Salicylic Acid: H. C. SHERMAN and A. GROSS.

The Identification of Mixed Coloring Matters in Foods: S. P. MULLIKEN.

Factors which Influence the Digestion of Food: P. F. TROWBRIDGE.

Aeration a Factor in the Purification of Water: W. W. SKINNER and G. W. STILES.

The Influence of Environment on the Composition of Wheat: J. A. LECLERC and SHERMAN LEAVITT.

Rate of Acceleration of Plant Growth with Increase in Temperature: FRED W. MORSE.

The Stimulation of Premature Ripening by Chemical Means: A. E. VINSON.

The Development of Catalase in Lower Fungi: ARTHUR W. DOX.

Wax of Candelilla or Mexican Wax Plant: G. S. FRAPS.

Formation of Ammonia Soluble Organic Matter in Soils: G. S. FRAPS and N. C. HAMMER.

Nitrates in Pineapple Soils: A. W. BLAIR.

Observations bearing upon the Practicability of Certain Chemical Methods of Testing Soils: H. J. WHEELER.

The Oxidizing Power of Soils: M. X. SULLIVAN and F. R. REID.

Oxidation Effects of Manganese Salts in Soils: J. J. SKINNER.

Variation in Methoxyl in Soil Organic Matter: EDMUND C. SHOREY and ELBERT C. LATHROP.

Relation of the Active Phosphoric Acid of the Soil to Deficiencies for Phosphoric Acid as shown in Pot Experiments: G. S. FRAPS.

Puren Bases in Soils: OSWALD SCHREINER and EDMUND C. SHOREY.

The Effect of Certain Plants upon the Nitrate Content of Soils: T. L. LYON and J. A. BISSELL.

Chemical Changes produced in Soils by Steam Sterilization: T. L. LYON and J. A. BISSELL.

The Detection of Deterioration of Corn and Corn Meal with Special Reference to Pellagra: C. L. ALSBERG and O. F. BLACK.

Some New Formulas for the Determination of Dextrose, Dextrine and Maltose: H. E. BARNARD and W. B. MCABEE.

A Study of the Keeping Qualities of Crushed Fruits, Fruit Syrups and Sugar Syrups: H. E. BARNARD and I. L. MILLER.

The Composition of So-called Temperance Beers: H. E. Barnard.

The Efficiency of Land Plaster in Preventing the Loss of Ammonia in Manures: Wilfred W. Scott.

BIOLOGICAL CHEMISTRY SECTION

In Joint Session with the American Society of Biological Chemists

S. C. Prescott, *Chairman*

The Phosphorus of the Flat Turnip: Burt L. Hartwell and Wilhelm B. Quantz.

It was found that the percentage of phosphorus in the dry matter of flat turnips was influenced by the amount of available phosphorus in the soil upon which the crop was grown. This led to the attempt to ascertain if any particular class of the phosphorus compounds was influenced principally.

About 10 per cent. of the phosphorus of the dry turnip was soluble in 95 per cent. alcohol, and about 70 per cent. was dissolved subsequently in 0.2 hydrochloric acid. Fifty to 70 per cent. of the phosphorus in this extract was precipitable by a molybdenum mixture containing only a small amount of free nitric acid. In fresh turnips about 80 per cent. of the total phosphorus was found in the somewhat colloidal aqueous extract, and over four fifths of this was directly precipitable by magnesium oxid and by the official mixtures of molybdenum and magnesium.

Nearly all of the phosphorus in turnip juice passed through a dialyzer. When added to a standard solution of sodium phosphate, the colloidal matter from within the dialyzer interfered with the complete precipitation of the phosphorus by the molybdic method. Hydrochloric acid added to turnip juice itself to the extent of 0.2 per cent. made it possible, after filtration, to precipitate nearly all of the phosphorus directly from the filtrate. Practically no phosphorus in phytin was present in the juice. It appears as if four fifths of the phosphorus of fresh flat turnips is in soluble compounds and exists mainly as so-called inorganic phosphorus.

Ratio of Plant Nutrients as affected by Harmful Soil Compounds: Oswald Schreiner and J. J. Skinner.

Results of a comprehensive study of culture solutions with and without dihydroxystearic acid, a harmful compound isolated from soils, were reported. The culture solutions comprised all possible ratios of the three principal fertilizer elements: phosphate, nitrate and potassium, varying in 10 per cent. stages. The culture solutions were changed every three days and analyzed, the remaining composition and ratio of the above fertilizer elements being thus determined. In this way the effect of the plant and of the dihydroxystearic acid on the composition and ratio could be determined. The triangular diagram is used in this work and makes possible the intelligent handling and presentation of the results.

Some of the principal results were as follows: The plant growth and absorption were greatest in the solutions containing all three fertilizer elements, but not in equal proportions, the greatest growth and greatest absorption being found in the region below the center in the triangle. The dihydroxystearic acid had the effect of shifting this region of greatest growth toward those ratios higher in nitrogen. Although absorption was greatest in this region, the ratios suffered the least change; the greatest change is produced in those ratios most removed from this normal region.

The harmful soil compound inhibited growth in all the solutions, but was the most harmful in those ratios not well suited for plant growth and least in those best suited for plant growth. Moreover, it is less harmful in the presence of those ratios mainly phosphatic or potassic and this effect is also associated with a higher nitrogen removal. The quantity of phosphate and potash removed was less in the presence of this compound. The investigations tend to throw much light upon the relations between plant growth, absorption, fertilizer action and influence of organic compounds.

Concurrent Oxidizing and Reducing Power of Roots: Oswald Schreiner and M. X. Sullivan.

The roots of growing plants, such as wheat, have the power to oxidize alpha-naphthylamine, benzidine, phenolphthalin, aloin, guaiac, pyrogallol, etc. When indicators like alpha-naphthylamine and benzidine are used, the colors due to oxidation are most intense on the region of the root where growth is most active, the most marked oxidation showing by a distant band of color just back of the root cap. Then comes a practically colorless zone and then a colored zone, the color becoming less intense toward the upper part of the root. Wheat roots grown in sodium selenite neutralized by hydrochloric acid reduce the selenite with a pink deposit of selenium upon the root. This deposit is most marked a short distance back of the root cap just back of the

region of greatest oxidative power, and appears there first. The points of emergence of the secondary roots also show the color strongly. The reducing power is more active in the young and vigorous roots. Roots killed by being dipped in boiling water have no reducing action. Roots in non-neutralized sodium selenite have little, if any, reducing action. In the main, with increased oxidizing power of the wheat root upon aloin, there is an increased reducing power upon neutralized sodium selenite. Potassium iodide in certain concentrations, however, retards oxidation but does not affect the reducing power and may indeed increase it.

The Cause of Depression produced by Molasses: J. B. Lindsey.

Experiments were outlined which had been carried on during the past year which showed conclusively that molasses prevents digestion. Many experiments with food molasses added to different sorts of mixtures for cattle, sheep and horses have been tried and it has been found a marked depression was produced by it. The reason for this is not exactly clear although many theories have been advanced to explain it.

Cornin, the Bitter Principle of Cornus Florida: Emerson R. Miller.

The root bark gives best yield. Carpenter considered the bitter principle to be an organic base. The compound separated by Geiger had a slight acid reaction. In pure condition it is perfectly white, has neither basic nor acid properties, is extremely bitter and crystallizes in fine silky needles or beautiful rectangular plates, according to conditions. Melting point 181° C.

Readily soluble in water, sparingly soluble in cold alcohol or cold acetone, but is dissolved to a considerable extent by these liquids at the boiling temperature. Almost insoluble in ether, chloroform, benzole, petroleum ether and acetic ether. Sparingly soluble in benzole or acetic ether at the boiling temperature.

Contrary to Geiger's statement its aqueous solution does not form a precipitate with either silver nitrate or lead subacetate.

Tested for nitrogen with soda-lime or metallic potassium it gave negative results.

An aqueous solution after standing some time assumes color and reduces Fehling's solution. By heating with a little alkali or acid it reduces Fehling's solution at once. It also reduces ammoniacal solution of silver nitrate and bismuth subnitrate in the presence of an alkali, and responds to Pettenkofer's test for glucose. An aqueous solution does not form a precipitate with phenylhydrazine hydrochloride, but on heating yields a yellowish red precipitate.

The average of ten analyses gave $C = 52.49$ per cent.; $H = 6.17$ per cent. Computed for the formula $C_{17}H_{24}O_{10}$, $C = 52.57$ per cent.; $H = 6.18$ per cent. A molecular weight determination by the freezing point method gave 377. The above formula requires 388. The average of two tests for methoxyl gave 7.48 per cent. One OCH_3 requires 7.98 per cent.

Cornin thus appears to be a glucoside whose molecule contains the glucose nucleus and, so far as determined, is represented by the formula $C_{16}H_{21}(OCH_3)O_9$.

The Selective Antiseptic Action of Copper Salts: Alfred Sringer.

Last year I found a certain Cincinnati "certified milk" contaminated with traces of copper salt, which in some cases, though containing only one part in two millions, decidedly affected the normal sequence of fermentative action and made the milk a better medium for the growth of certain molds. In the course of my experimentation I found that the copper salts were highly selective, being most efficient in inhibiting the putrefactive germs, as evidenced by tests made with egg albumin, blood albumin, meat and other nitrogenous substances, with and without the addition of copper salts. These results may be caused either by the copper salts preserving the substances in their original condition, or splitting them without the formation of odorous compounds or dissociating the odorous compounds themselves into non-odorous ones.

It seemed to me that some light might be thrown upon the action of these salts by experimenting with copper treated eggs and then placing them in an incubator. In the first series of experiments I completely submerged many eggs in a cupric sulphate solution and check ones in distilled water. Those in the distilled water kept about two months, the others after a year's time have not become foul. When, however, eggs which had been completely submerged several weeks in a copper or distilled water solution, were placed in an incubator no chickens hatched. The distilled water experiments showed that it is fatal to prevent air from reaching the germinative part of the egg. The preservative effects of the copper salts might have been due to their rendering the eggs to a condition similar to that of unfertilized ones (which keep far better than the fertilized)

or inhibiting the putrefactive microorganisms without effecting germinative properties. In order to determine this, I made another series of experiments by placing eggs upright in copper and distilled water solutions with the broad end projecting above the liquid so that air could enter into that part. In another set, one half of the egg was longitudinally immersed in copper sulphate solutions and distilled water twenty-four hours, then turned so that the other half would be immersed twenty-four hours, but at all times air had free access through the upper half. After seventeen days' treatment, these eggs as well as some check untreated ones were placed in the incubator. On the twentieth day a chick hatched from an egg which had been three quarters immersed in distilled water seventeen days. I waited five days longer, and, no other chick coming out of any shell, I opened the eggs and found that two of the fertile ones had almost completely developed. One of these was from a partly submerged egg and the other from alternately immersed and daily turned one.

From the eggs containing the chicks, I sucked up part of the liquid with a pipette, digested it with sulphuric acid in a Kjeldahl flask and tested for copper. It was not even necessary to digest the liquid, as it could be diluted with water and electrolyzed direct, the copper depositing on the cathode. This evidently showed, as you see by these specimens, that embryonic growth to almost complete development took place, although the imbedded liquid was practically a copper bath. While these experiments are still very incomplete, it strikes me all signs point to the belief: that small amounts of copper salts in their selective antiseptic action towards the putrefactive ferments and unpronounced effects on others, may be of great therapeutical value.

Destruction of Invertase by Acids and Alkalies: H. S. PAINE.

Samples of the same invertase preparation were kept at a constant temperature of 30 degrees for different time intervals in acid (HCl) and alkaline (NaOH) solutions at varying concentrations. At the end of the respective time periods all the samples were brought to the same acidity (the acidity favorable to optimum activity of the enzyme) in cane sugar solutions of the same strength, all volumes being equal. After an inverting action of one hour, the velocity coefficient, K, of the rate of the inversion was calculated from the formula for monomolecular reactions, viz: $K = 1/t \log (R_0 - R\infty / R - R\infty)$, where R_0 is the rotation of the pure cane sugar solution, $R\infty$ the rotation of the same solution after complete inversion and R the polarization at the time t, seconds and decimal logarithms being used in the calculation. The activity of the enzyme, as measured by the above coefficient, K, was found to decrease as the strength of the destroying acid or alkali solution was increased.

By an application of the above formula a coefficient, K', measuring the rate of destruction of the invertase was obtained as a derived value of the coefficient just referred to.

Destruction commenced at about 0.015 normal in acid and 0.01 normal in alkaline solution, requiring about five to six hours for completion at those concentrations. It was very rapid and required only about five minutes in 0.05 normal acid and 0.04 normal alkaline solution, showing that, while invertase is inactivated in very faintly alkaline solutions, the destructive action of alkalies on it is not much greater than that of acids.

In view of the fact that the degree of acidity or alkalinity of the media in which many enzymes naturally occur is subject to change, quite often between wide limits, investigations, such as the one just described, are of value in determining just when inactivation or destruction takes place. As only one instance of such media of changing acidity and alkalinity may be mentioned the alimentary tract of the higher animals, considered in its entirety.

The Estimation of Arsenic and Morphine in Animal Tissue: CHARLES R. SANGER.

One three-thousandth part of an ounce of arsenic and one thousandth part of an ounce of morphine can readily and quickly be detected by the new method, and it is expected that all uncertainty in post mortem examinations will be eliminated by the new method of analysis.

Stagnation vs. Circulation in House Air: ELLEN H. RICHARDS.

The science of living is more and more engaging the attention of those who are exploring the borderland of chemical physics of chemical biology. No part of this land is more unknown than the air we breathe and its significance in mental activity.

In no quarter do we do greater wrong than to our young students, by compelling them to listen to lectures, and to work, in an atmosphere that dulls their wits and befogs their minds. It is quite time that the biophysicist wrote a convinc-

ing tract on draft and its necessity. Let us take advantage of the tuberculosis scare and change the habits of people so that they may not need to drop all their occupations and sit in a draft all day doing nothing.

An artificial life demands artificial means of securing the advantages of natural living. One man's fresh air is another man's draft and the most difficult part of the ventilation problem is to reconcile the interests of both these classes of persons.

It is now pretty generally recognized among the scientific workers most familiar with the facts, that there is little danger from breathing germs except from direct contact with the particles given off by sneezing, coughing, etc., and this only within a radius of ten feet or so of the distributing factor. Also that in itself carbon dioxide, up to even 50 or 75 parts in 10,000 does not disturb the individual in a cool, dry room.

The window lowered an inch at the top is of more power than raised a foot at the bottom. Because air is invisible, the average person ignores it. If more attention could be paid to air currents, to the mixing of air, and as an aid to this, if the air of halls could be kept cooler, vast benefit would result. Heat and humidity are the most dangerous products of still life, because they so soon endanger the activity of the cells and raise the body temperature.

Odors also form no unimportant part in the causes for discomfort in our enclosed spaces. May not circulation of air combined with ozonization do much to eliminate this? We have tests under way looking to this end.

The following papers are reported by title:

Industrial Bacteriology as a Field for Biochemical Investigation: Samuel C. Prescott. (Chairman's address.)

Studies upon the Physiological and Chemical Toxicology of the Sap of the Manzanillo Tree: Jose A. Fernandez Benitez.

Some Points in the Analysis of Proteins: T. B. Osborne.

A Method for the Determination of Amino Nitrogen and its Applications: Donald D. Van Slyke.

The Anaphylactic Reaction as a Specific Test for Protein: M. J. Rosenau.

The Manganese-bearing Tissues of the Fresh-water Mussels: H. C. Bradley.

The Relation of Typhoid Fever to the Water Supplies of Illinois: Edward Bartow.

The Action of Enzymes on Sugars: C. S. Hudson.

The Cause of Depression Produced by Molasses: J. B. Lindsey.

The Chemical Organization of a Typical Fruit: A. E. Vinson.

Fixing and Staining Tannin in Plant Tissues: A. E. Vinson.

DIVISION OF ORGANIC CHEMISTRY

R. S. Curtiss, *Chairman*
Ralph H. McKee, *Secretary*

Advances in the Chemistry of Coal-tar Colors: Hugo Schweitzer.

Enormous progress is yearly made in the industry of coal-tar colors where the far-reaching possibilities of chemistry have been recognized. It is the popular idea that aniline colors can not stand the influence of light. This is due to the fact that the first aniline colors were poor. This is not true of the aniline colors now made. The most wonderful advances in the production of new colors of extreme fastness are to be found in the class of alizarin colors, which for the last twenty years have played a very important part in the dyeing industry.

Many interesting experiments have been made to determine the fastness of certain dyes, among them the experiment of dyeing a blue fabric and exposing it to the sun's rays at the height of many thousand feet. Since a method has been discovered for the manufacture of artificial indigo economically, many different kinds of dyes have been made from this indigo, which plays an important part in the industry. Friedländer has made some interesting investigations to show that the purple of the ancients, which was derived from purple shell fish of the Mediterranean, was identical with some of the modern derivatives of indigo. From 12,000 shell fish he obtained one twentieth of an ounce of color, which shows why it was so precious and expensive in the olden times.

Within a few years it has even been possible to make coal-tar colors for the use of artists. While the product in Thessaly of a few pounds of dyestuff would be sufficient to supply the painters of the world with this color it is practically nothing. Experiments were carried out for the benefit of art. They are being continued so that in the end organic colors will reign supreme in this field.

A comparison of the natural colors of a few years back with the artificial colors of to-day show that in every case the artificial colors are

much better as well as cheaper, while the variety of shades that can now be obtained is almost infinite. The much-vaunted achievements of the good old times are of necessity a myth as far as fastness of dyes or superiority of textiles are concerned, and the purple and fine linen of the ancients would look decidedly queer in a modern department store. The fabrics which the daughters of the Pharaohs used for their personal adornment would not find favor in the eyes of the poorest women of the present day.

Saponification of Formic Esters: J. STIEGLITZ and EDITH BARNARD.

The velocity coefficient for the saponification of ethyl formate by the hydroxyl ion at 25° was determined by means of a mixture of ammonium hydroxide and chloride and found to be 1,840. For methyl formate the constant 2,800 was found. At the same time there is amide formation, the constant for which was found to be 0.13 for methyl formate at 25°.

Stereoisomeric Chlorimidoketones: J. STIEGLITZ and P. P. PETERSON.

Stereoisomeric chlorimido-p-chlorbenzophenone, chlorimido-p-methoxybenzophenone and chlorimido-p-chlor-p-methoxybenzophenone were described.

Phthalamidic Acids Substituted in the Benzene Nucleus: J. BISHOP TINGLE and S. J. BATES.

It has been shown by the senior author and his co-workers that phthalamidic acids, $RNHCOC_6H_4\text{-}CO_2H$, when warmed with amines are transformed readily into imides,

$$C_6H_4<\genfrac{}{}{0pt}{}{CO}{CO}>NR,$$

and other products. Aliphatic amidic acids of a similar type,

$$RNHCO\overset{|}{\underset{|}{C}}\overset{|}{\underset{|}{C}}CO_2H,$$

under similar conditions, fail to react in this manner and their salts with amines are also stable. The investigation has been extended to include several amidic acids derived from 3-nitro-, 4-nitro-, 3, 6-dichloro- and tetrachlorophthalic acids, in which R as in the formula above is phenyl- or β-naphthyl-. The general effect of these substituting groups (Cl or NO_2) is to render the amidic acid very stable towards amines, but it is readily changed to the imide by the action of alcohol which may be as dilute as 50 per cent. The reaction is not produced by other solvents under similar conditions of temperature.

Camphor phenyl- and β-naphthylamidic acids are not dehydrated by amines. Camphoric acid therefore behaves like an aliphatic compound.

Melting and Boiling Points of Certain Disubstitution Products of Benzene. By J. BISHOP TINGLE.

The statement, which is rather widely current, that para disubstituted benzene derivatives usually melt and boil at a higher temperature than the isomeric ortho- and meta-compounds requires qualification, as is shown by the following results:

Boiling Points.—(1) The b. p. *increases in the order ortho-, meta- and para-* in the case of compounds containing the substituents Cl, OH; Br, OH; I, OH (?); OH $(OH)_2$; CH_3, NO_2; CH_3, NO_2; C_2H_5, NO_2; CH_3, Br; CH_3, CO_2H. (2) The b. ps. of the *meta- and para-compounds are essentially identical and are lower than those of the ortho-derivatives* when the substituents are CH_3, Cl; $(CH_3)_2$; $(C_2H_5)_2$; Cl_2; Br_2; I_2 (?); Cl, Br; Br, I; Cl, I (?); $(NO_2)_2$ (?); HO, NO_2 (?); Cl, NH_2; Br, NO_2. (3) The b. p. *rises in the order meta-, ortho-, para-* in the case of the compounds, $CH_3CH_2CH_2$, CH_3; C_2H_5, NH_2; $(NO_2)_2$ (?); HO, NO_2 (?). (4) *The increase of temperature is in the order meta-, para-, ortho-* with the substituents Cl, NO_2; I_2 (?); HO, NO_2 (?). (5) *The increase is in the order para-, meta-, ortho-* in the case of Cl, I. This is the converse of 1. (6) The order is ortho-, para-, meta- with the groups $(NH_2)_2$. (7) The b. p. of the *ortho- and meta-compounds are essentially equal, that of the para-derivative being higher* in presence of CH_3, I. (8) The b. p. of the *ortho- and para-*derivatives are substantially equal, those of the *meta-*compounds being higher or lower in the case of C_2H_5, Br; $(CH_3)_2CH$, CH_3.

Melting Points.—The m. ps. of the substances mentioned above are much more simple. The following come under class (1) above: HO, Cl (?); HO, Br (?); $(OH)_2$; HO, NO_2; H_2N, NO_2; Cl, NO_2; Br, NO_2; $(CO_2H)_2$ (?); H_2N, CO_2H; CH_3, CO_2H; H_2 (in the case of $C_6H_2I_4$); I_2; CH_3, NO_2. The remaining compounds fall into class (3) above. They are as follows: I, NO_2; Br, NH_2; I, OHX; I, NH_2; HO, NH_2; $(NO_2)_2$; O_2N, CO_2H; C_2H_5, CO_2H; $(NH_2)_2$.

No m. ps. have been found which correspond to the relationship shown in the b. ps. of the compounds in classes (2), (4), (5), (6), (7) and (8). The small number of substances in the last four classes suggests that the published data may require correction. The classification given above is based on the best figures which were available,

but from the nature of the case, the degree of accuracy attained by different investigators is very variable. In the case of compounds followed by (?) the classification is open to doubt.

Hydrazones of Certain Oxy-Ketones; Alkali-Insoluble Phenols: HENRY A. TORREY.

Although it is a very general rule that phenols are soluble in aqueous alkalies there are certain substances of this class that are marked exceptions. The phenolhydrazones of certain acetophenols and acetonaphthols are entirely insoluble in aqueous alkalies. This alkali-insolubility is determined by two conditions: (1) the free hydroxyl group is ortho to the substituted ketone side chain; (2) other substituting groups, as OCH_3, or hydrocarbon groups are present.

The importance of the second condition is seen in the fact that while the phenylhydrazone of o-oxyacetophenone is soluble in aqueous alkalies, the same derivatives of paeonal or a-acetonaphthol are insoluble. The azines of a-acetonaphthol is insoluble in aqueous alkalies, whereas in general the azines have been found soluble, even though the phenylhydrazones are insoluble. No condensation between the imino and hydroxyl groups has taken place. There seems to be no evidence to suggest that these alkali-insoluble phenols should be weaker acids than corresponding bodies that are soluble. The acetyl derivatives obtained by Auselmino from similar alkali-insoluble phenylhydrazones of oxyphenylaldehydes point to the presence of the hydroxyl group. It is possible that the consideration of a quinoid structure may assist in the explanation of the alkali-insolubility of these compounds. They furnish an interesting instance of the effect that a substituting group may have upon the whole equilibrium of the molecule.

Furoylacetic Ester and Furyl-Pyrazolones: HENRY A. TORREY and J. E. ZANETTI.

Furoylacetic ester, as might be expected, closely resembles acetacetic ester and benzoylacetic ester. Its oxime, however, is more stable, although it can be converted into the corresponding isoxazolone without difficulty. The comparative stability of the oxime shows that the furyl group has a greater attraction for the hydroxyl of the oxime radicle than would be indicated by the position assigned to it by Hantzsch in his list of groups arranged in order of their power of attraction for hydroxyl in this class of compounds. Since pyromucic acid has a considerably higher dissociation constant than either benzoic acid or acetic acid, the comparative stability of the oxime of furoylacetic ester is better explained by the views of Abegg, according to which the difference in electrical charges of the groups influencing the hydroxyl of the isonitroso group is considered.

Furoylacetic ester forms hydrazolones easily with hydrazines, thus with aryl hydrazines, 1-aryl 3-furyl 5-pyrazolones are given. As would be expected, these pyrazolones show tautomeric relationships. With benzaldehyde a condensation product was formed with one molecule of the pyrazolone and with diazo salts highly colored azo compounds were prepared. Acetyl and benzoyl derivatives were readily formed.

From 1-phenyl 3-furyl-5-pyrazolone by the action of methyl iodide the hydriodide of 1-phenyl 2-methyl 3-furyl-5-pyrazolone was obtained, an analogue of the drug "antipyrine." Other salts, such as the hydrochloride and hydrobromide, were made, but owing to the negative nature of the furyl group they are easily hydrolyzed by water giving the free body in the form of an oil difficultly soluble in water.

Methyl Phenyliminomalonate and its Reactions: RICHARD SYDNEY CURTISS and F. GRACE C. SPENCER.

This compound $C_6H_5N = C(CO_2CH_3)_2$ is made by the action of P_2O_5 on methyl anilinotartronate, the addition product of aniline on methyl oxomalonate. It shows remarkable reactivity at the nitrogen-carbon double bond. Moisture of the air rapidly changes it to methyl dianilinomalonate and methyl dihydroxymalonate; a complex reaction, involving the formation of aniline and methyl dehydroxy malonate and their interaction to produce the final products. Aniline acts on methyl phenyliminomalonate giving methyl dianilinomalonate. Alcohols, amines and many other classes of compounds containing easily dissociable hydrogen, add directly to the double bonds. The substance is a striking analogue of phenylisocyanate. Mercuric oxide oxidizes methyl anilinomalonate yielding methyl dianilinomalonate and methyl oxomalonate. This reaction is complex and its mechanism may be explained by assuming that methyl anilinotartronate first formed dissociated to methyl phenyl iminomalonate, and that this was changed by water into the final products as stated above. Further studies are in progress on phenyliminomalonates.

On 4- and 5-acetamino Acetanthranils and Quinazolines derived therefrom: M. T. BOGERT and C. G. AMEND.

2, 4- and 2, 5-tolylene diamines were acetylated, the acetyl derivatives oxidized to the corresponding diacetamino benzoic acids, and the latter converted into the acetamino acetanthranils by boiling acetic anhydride. By condensing these acetamino acetanthranils with primary amines, and other primary amino compounds, acetaminoquinazolines were obtained, from which the acetyl group was easily removed, leaving amino quinazolines whose amino groups were then subjected to various well-known aniline reactions.

The Preparation of Styrolene Alcohol: Wm. Lloyd Evans and Lou Helen Morgan.

Styrolene diacetate can be prepared quantitatively by the interaction of fused lead acetate (1.5 mols.) and styrolene diacetate (1 mol.) dissolved in glacial acetic acid (six times the weight of the dibromide used). The reaction begins at 120° and is practically complete at 125°. Styrolene alcohol can be prepared by the hydrolysis of styrolene diacetate (1 mol.) by means of potassium carbonate (1.5 mols.) dissolved in water (twenty-five times the weight of the diacetate used), the solution being kept to boiling for two hours. From the cooled reaction mixture, subsequently saturated with potassium carbonate, the greater portion of the alcohol may be precipitated, the remainder being obtained from the filtrate by extracting with ether. Oxidation experiments are now in progress on styrolene alcohol and also on propylene glycol.

The Glycogen Content of Beef Flesh: P. F. Trowbridge and C. K. Francis.

The experiment in enzymatic hydrolysis has been continued on similar lines to those reported in the previous paper, working on the liver of beef animals instead of the shoulder muscle. At temperature of 20° to 25° a liver, containing 3.15 per cent. glycogen when exposed for about three days contains about 2 per cent. of glycogen.

Various authorities state that horse flesh contains from 1 to 2.4 per cent. glycogen and it is claimed the muscle of the ordinary horse has as much glycogen as the liver. Our investigations have not confirmed this assertion. Working on a sample of fresh horse flesh obtained from a thin animal about twenty years old, we have obtained only 0.18 per cent. glycogen in the muscle. In twenty-one hours this amount was decreased 67.3 per cent., while in three days the loss was 91.1 per cent., accompanied with a slight decomposition of the sample. In the fresh shoulder muscle of beef we have found as high as 0.7 per cent. of glycogen as previously reported. According to these results the determinations of the glycogen as distinguishing horse flesh from beef is of no value.

The following papers are reported by title:

Synthetic Medicinals: Recent Progress in Relationship between Physiological Action and Structure: Virgil Coblentz.

The Action of Acetylene on Iodine Trichloride: H. Edmund Wiedemann.

The Condensation of Methyl-ethyl-ketone by Acids and Alkalies: Alfred Hoffman.

The Constitution of Retene and its Derivatives: John E. Bucher.

The Properties of the Hexa-substitution Products of Ethane: James F. Norris.

Studies in Tautomerism: S. F. Acree.

The Basic Properties of Oxygen; Compounds of Dimethylpyrone and the Halogen Hydrides: D. McIntosh.

The Constitution of Ortho-benzo-quinone: Wm. McPherson and Howard J. Lucas.

Esterification and Steric Hindrance: M. A. Rosanoff, C. D. Wright and T. F. Power.

The Constitution of the Carboxonium Salts: M. Gomberg and L. H. Cone.

The Constitution of the Carbothionium Salts and of the Acridine Salts: M. Gomberg and L. H. Cone.

The Constitution of Benzene from the Standpoint of the Corpuscular-atomic Conception of Positive and Negative Valences: Harry Shipley Fry.

The Formation of Cyclopentadiens: William J. Hale.

Some Organic Compounds of Selenium: Howard W. Doughty.

A Measure of Thermodynamic Positivity and Negativity in Water Solution with Reference to Chemical Reactions of Organic Compounds: C. G. Derick.

The Addition Power of Methylethyl-ethylene: Roger F. Brunel.

Equilibrium at High Temperatures between Isobutyl Bromide and Tertiary Butyl Bromide: Roger F. Brunel.

The Iodine Compound of Pinene and the Resin formed by the Action of Iodine on Pinene: G. B. Frankforter and B. F. P. Brenton.

CHEMICAL EDUCATION SECTION

Lyman C. Newell, *Chairman*

The Purpose and Method of the Chemistry Course in the Public High School: Frank B. Wade.

The author first classified his material into three groups: (*a*) those who expect to go to college, (*b*) those who wish to use their chemistry vocationally, (*c*) those who wish chemistry as part of a good general education. He regarded (*a*) as a majority of influence, but (*c*) as a numerical majority. He next showed that the best course for class (*a*) would really serve classes (*b*) and (*c*) better than any other course.

Going more into detail, it was shown that for all three classes the course should be along broad general lines. The fundamental principles, the leading facts and the most useful theory should be taught. More than all else the scientific mode of thinking should be inculcated, together with the habit of going to things themselves rather than to authorities for facts. The ability to attack hard problems systematically and successfully should be imparted to the pupils.

This sort of course was shown to be the best possible preparation for college chemistry, also for vocational chemistry and for general training.

In the last part of his paper the author took up briefly the matter of how the kind of course outlined might be taught, and attempted to convey an idea of the spirit of the method rather than pedagogic details of method, placing emphasis upon open mindedness and breadth rather than upon specialization in high school chemistry.

Content and Method of the First Course in Chemistry: M. D. SOHON.

The social development has been so largely shaped through the application of scientific principles that an understanding of the elementary principles of physics and chemistry is necessary for the ordinary man.

The introductory course should be so adapted as to be within the capacity of any child in the high school. It should be planned for the many rather than the few.

The content of the course should be such as to give a comprehensive view of the principles involved in *ordinary* chemical phenomena, together with non-technical treatment of commercial products, their sources, utilization and preparation.

The difficulties of the subject are largely artificial and due to acceptance of traditional methods and content. The theoretical conceptions are difficult, but fortunately such are not essential to the study of the principles involved in the elementary study of the subject.

This can be done better with elementary pupils by the systematic study of topics and of processes than by the study of elements. Traditional methods followed by texts fail to make use of modern experiences and facilities in their method and arrangement. The subject should be approached from the side of the pupil, sacrificing, if necessary, the formal development as a science.

Laying aside the old methods and examining the subject from the side of the pupil, there is ample material to be drawn upon, facts worth knowing. Their relations and values may be taught with little or no regard to abstractions.

For the pupil who will continue in school it will serve as a foundation for more intensive work. The pupil who does not continue will have had his interests aroused to increased efficiency.

Pressure should be brought to bear upon the schools to make the instruction more practical. It is within the power and is the duty of the society to meet this and say what is desirable or practical and not leave this to popular clamor or self-constituted authorities.

The Relations of the Common and of the more Uncommon or Immiscible Reagents: CHARLES S. PALMER.

A short paper urging the teaching of the action of the common acids, bases and salts on the common oils, fats, waxes, and such substances as paper, sizing, ink, cotton, wool, etc. All this should be shown the beginner, and adopted and incorporated with the usual good theory and practise. This means more thorough courses in preparatory chemistry comparable with the completeness and thoroughness of the good old-fashioned specializing in Latin and Greek. This toning up of preparatory chemistry should come from the inspiration and insistence of the college influence on the preparatory school.

Elementary Chemistry in the Vocational High School: LYMAN GORHAM SMITH.

The vocational school trains for efficiency in special lines of work, and generally makes but indirect use of chemistry. Employers are demanding that the pupil acquire habitual knowledge, or that he be well drilled; educators, on the other hand, unanimously emphasize the value of the development of initiative, and of the power of independent judgment. The latter must be protected, as it is against the best interests of pupils to make them merely the profitable tools of employers. Schools can do much to train more efficient and useful workers, but the spirit of ideal democratic American education is not to be neglected.

The scientific attitude of observing accurately and drawing sensible conclusions is a most essential element in vocational education. Plato, Leonardo da Vinci, Charles Kingsley and many others, including a host of theoretical and practical modern educators, are earnest advocates of the scientific method. The spirit of investigation is natural to even young children. Leaders in pedagogy and in science in England, in Germany and in America are promoting inductive laboratory study. Vocational high schools need to train pupils for power of judgment, must teach fundamental principles, and such cases of the practical applications of chemistry as are typical. The difference between factory and laboratory practise should be made clear. Works should be visited, and a few experiments, at least, should be carried out on a commercial scale by the pupil. Much real inductive laboratory study is essential at the start, and an acquaintance with the spirit of the methods of attacking practical experimental problems should be gained. Above all, at the beginning of the study of chemistry, the pupil should be made independent of text-books, the authority of which he should learn to regard with discriminating suspicion; though later he may use them to some advantage. Many of the subjects taught in high schools, as algebra, depend on text-books, but the peculiar quality of science instruction lies in the cultivation of the scientific attitude. The conscientious pursuit of truth is an important moral element in education. Efficiency in vocational education results from accurate and reliable knowledge, respect for scientific methods, regard for the evidence furnished by data, and appreciation of the value of the work of experts.

The Case Against Qualitative Laboratory Experiments: EDWARD ELLERY.

The case against qualitative laboratory practise is as follows:

1. It is a waste of the student's time to repeat in the laboratory what has been done in the lecture room. There is so much to give now like the thermal and electrical relations that time can not be spared for the student to find out whether an element acts or does not act as the book says.

2. The student gets a wrong idea of the rigidity of the laws and the care and accuracy necessary in chemical work by his careless performance of the experiments.

3. Such qualitative experiments do not make for independence. The notes can be written up from what is given in the books or seen in the lecture room. Such work is not the most profitable use to make of one's time.

4. Good results are often not obtained, due to use of faulty apparatus, hurried work and careless use of materials.

The advantages of doing quantitative work are pointed out. They may be summed up as follows: (1) quantitative experiments are not beyond the capacity of beginners, (2) quantitative work emphasizes the chemistry of the reactions and demands more critical observation, (3) the cost of fitting up a quantitative laboratory need not be large, (4) the experience gained in quantitative experiments will be of use later on when the student does analytical work.

The Teaching of Chemistry in Secondary Schools: MOSBY G. PERROW.

It is pointed out in this paper that too much is attempted in a one-year course in a secondary school. This is due to the severe entrance requirements of some colleges and to the very many subjects given in the text-books. As a result no thorough careful work is done and the student gets discouraged at the amount of work he has to do.

Educational Value of Chemistry: W. S. LEAVENWORTH.

The difference is brought out between a study of the classics and a study of physical science. The advantages of laboratory work are given in which it is shown that it cultivates clear thinking and right doing, develops perception and the rational faculties and inculcates the capacity for honest, thorough work. In the laboratory the student learns by doing and does by learning. The laboratory demands accuracy of eye, teaches necessity for care, exactness and cleanliness. The imagination also has a place in chemistry, as we see from Dalton and Mendeleff. Chemistry is an enemy to superficiality; it cultivates clear expressions and exact thought, in a broad way it teaches us why and how to live. Science in its best and broadest sense gives us the only rational explanation of living and therefore is essential to any system of education.

A Method of Preparing Qualitative "Unknowns": L. J. CURTMAN.

The stock solutions are prepared of strength indicated in column 5 (except in cases where the solubility of the salt will not permit of such a concentration) and kept in bottles of one or two liters capacity provided with graduated pipettes. We are thus able to deliver definite quantities of

Substance	Formula Weight	Solubility in 100 pts. of Water at 20°	Per Cent. Metal	Quantity of Salt to be Dissolved in 1 Liter to Give Strength 1 c.c. = 100 mgs. of Metal
$NaCl$	58	35 g.	40	250
KNO_3	101	25	39	257
NH_4NO_3	80.1	200	22.5	445
$BaCl_2 2H_2O$	244	41	56	180
$Ca(NO_3)_2 4H_2O$	236.2	extremely soluble	17	590

these standard solutions to students as "unknown" bottles; these consist of homœopathic vials of 50 c.c. capacity. For the analysis the student takes 25 c.c. of his solution, the other half being reserved in case of accident.

The amounts of standard solutions pipetted out should be such as to yield a suitable concentration when the volume is diluted to 50 c.c., *i. e.*, when the bottle is filled.

Example: Pipetted out into "unknown" bottle: 1 c.c. NaCl sol, 2 c.c. $Ca(NO_3)_2$, 1 c.c. NH_4NO_3, and then fill the bottle with distilled water.

Since the student uses only 25 c.c. of this solution the latter will contain: 50 mgs. Na, 100 mgs. Ca, 50 mgs. NH_4.

The following papers were reported by title:

Conditions under which Secondary School Teachers Conduct their Work: ALBERT L. SMITH.

Conditions and Equipment in Secondary Schools: CHARLES R. ALLEN.

Elementary Chemistry Teaching as a Means of Developing the Power of Independent Scientific Reasoning: ARTHUR A. BLANCHARD.

The First Course in Chemistry for Secondary Schools: M. D. SOHON.

D. L. RANDALL,
Press Secretary

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 225th meeting of the society, held on Wednesday, January 12, Mr. Fred. E. Wright exhibited specimens of obsidian from Hrafntinnuhryggur, Iceland, with peculiarly pitted surfaces, resembling the markings of the Austrian moldavites; also a unique type of crystallization of radial spherulites in cavities of that obsidian.

Mr. David White exhibited a photograph of an unusually large and complete Stigmaria stump, taken in an anthracite mine near Scranton, Pa. It afforded an excellent illustration of a "kettle bottom" or "pot," a common source of danger in coal mines, and clearly showed the hole in the roof above the fallen stump.

Mr. Chas. Butts described a Carboniferous coal bed overlain by Lower Cambrian limestone, near Aldrich, Ala., the limestone being thrust over the coal at the fault bounding on the east the Carboniferous rocks of the Cahaba trough. The coal is completely overturned, lies flat at the exposure, and is unchanged except for being crushed and mixed with shale.

Regular Program

Influence of the Earth's Rotation on the Lateral Erosion of Streams: H. M. EAKIN.

Observations on Alaska rivers indicate a higher efficiency of the deflective force of the earth's rotation in determining lateral erosion of streams than has been ascribed to it. The Yukon River and its tributaries, the Tanana, Koyokuk and Innoko, and the Kuskokwim, all large Alaska streams, show a marked predominance of erosion on the right bank. The strength of the deflective force as computed and compared at different latitudes shows it to be much stronger in the higher latitudes. For instance, for latitudes 5°, 25°, 45° and 65°, the ratios are approximately 1 to 4.8 to 8.0 to 10.3. The effectiveness of the deflective force may be compared with that of the centrifugal force of various curves of rivers, that of the deflective force at latitude 65° being approximately equivalent to that of the centrifugal force developed on a curve having a radius of 6.2 miles, computations being based on an assumed velocity of 2 meters per second. The lateral stresses due to either centrifugal force or deflective force tend to establish cross gradients which would oppose them. The lateral stresses being weaker in the lower part of the stream, the stronger lateral gradient supported by the upper part of the stream sets up an undertow in a direction opposite to that of the lateral stresses. The results of the boring currents thus produced are expressed in selective cut and fill. The deflective force being to the right in the northern hemisphere combines with the centrifugal force on right curves and opposes it on left curves. On straight reaches the deflective force acts alone. In a meandering stream the lateral gradients are reversed on successive bends and the lateral stresses are not fully expressed in lateral currents, since they are under conditions of acceleration much of the time. On straight reaches, there

being no reversal of lateral gradient, the deflective force becomes relatively much more efficient in inducing lateral currents.

The Missouri River, studied for comparison with the rivers in higher latitudes, shows evidence of unbalanced lateral erosion in the distribution of its flood plain with respect to its course.

Winds, crustal warping and asymmetry of drainage basins are other causes which may unbalance lateral erosion, but conditions do not point to their operation in the cases mentioned. The unbalanced erosion in the Alaska rivers, therefore, seems undoubtedly due to the deflective force of the earth's rotation.

Geologic Thermometry: FRED. E. WRIGHT.

In ordinary thermometry, temperature, or the degree of hotness of a body, is defined by the expansion of a perfect gas and is expressed in terms of fixed units, determined by the freezing and boiling points of water under standard conditions. Temperatures are ascertained practically by means of thermometers which, although they vary greatly in type, are all based on some property which varies in a definite way with the temperature. In geology, temperatures are of fundamental importance, particularly the temperatures to which rocks were heated in past geologic ages and under inaccessible conditions. Points on the geologic thermometer scale must therefore be historic points, or temperatures at which permanent changes occur in the rock or mineral, traces of which persist at lower temperatures. Such definite points serve to establish limits within which observed reactions must have been effected. The factors which may serve to furnish points of this nature are, especially: melting temperatures of stable minerals and of eutectics; inversion temperatures of minerals; temperature limits beyond which monotropic forms can not exist under different conditions of pressure; stable ranges of enantiotropic forms and of minerals which dissociate or decompose at higher temperatures; temperatures beyond which any physical property acquires a permanent set and by virtue of internal friction or other cause does not return to its original value on cooling; also the occurrence of zonal growth in isomorphous mixtures like the feldspars or pyroxenes. These factors can be and are being determined by modern laboratory methods and are in turn directly applicable to the study of rocks. In applying such data geologically, however, it should be remembered that the data are obtained under certain definite conditions while in nature the rocks may have been and often were formed under totally different conditions of equilibrium. Two factors particularly may be operative in this direction, pressure and solution, or the presence of other components, as water, which tend to modify very materially the equilibrium criteria and behavior of the physical chemical system in question. The data now available on the geologic thermometer scale indicate that the establishment of such a scale is feasible and can be accomplished by a sufficient number of proper laboratory determinations; also that in many cases the application of such data to natural phenomena is warranted.

The Origin of the Pegmatites of Maine: EDSON S. BASTIN.

The pegmatites of Maine all belong to the type commonly known as granite pegmatites. The fact that their chief minerals are also the dominant minerals of the granites, the presence of granite in all districts where pegmatites occur, and numerous observed transitions from granite to pegmatite, indicate that the pegmatites are closely related to the granites in origin.

The peculiar textures exhibited by the pegmatites as compared with the granites are *not* believed to be due mainly to differences in the proportions of the principal mineral constituents or of the rare elements such as fluorine, lithium and phosphorus, but probably to greater abundance of gaseous constituents in the pegmatite magma as compared with the granite magma. The principal gaseous constituent was probably water. There are field indications that the pegmatite magmas locally exhibited a considerable degree of viscosity, sufficient for example to float fragments of the schist wall rock. This and other facts suggest that the vaporous content of the pegmatites was not so greatly in excess of that of the granites as has commonly been supposed. Experiments by F. E. Wright and E. S. Larsen on specimens collected by the writer from the pegmatites of Maine show that the quartz from the finer-grained pegmatites and from the graphic granite of the coarser pegmatites crystallized above 575° C., whereas that of the large areas of pure quartz, the quartz crystals, developed in miarolitic cavities and the quartz associated with tourmaline, lepidolite, spodumene, etc., near the pockets in the gem-bearing pegmatites, was formed below 575° C. This fixes the temperature of crystallization of many of these pegmatites at about 550° and 600° C.

FRANÇOIS E. MATTHES,
Secretary

SCIENCE

FRIDAY, MARCH 4, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

SOME REFLECTIONS UPON BOTANICAL EDUCATION IN AMERICA[1]

IN the address with which he welcomed the American Association for the Advancement of Science to Columbia University three years ago, President Butler centered his remarks on a matter of the first scientific and educational importance. He said, in effect, that for a quarter century he had been a close and friendly observer of the progress of the sciences in education, that during this time he had seen them win almost complete recognition and opportunity, but that he was obliged to confess to some disappointment at the results. He was not referring to the sciences in technical education, for in this field their status is satisfactory, but to their position in general or cultural education. He did not presume, he said, to suggest either an explanation or a remedy, but he submitted the matter to the consideration of his expert audience. These words of this eminent educational observer touched an answering chord in my own thoughts, and since that time I have found, by inquiry among my colleagues, that he voiced a feeling quite general among scientific men themselves. It seems, therefore, to be a fact that the sciences, although dealing in knowledge of matters of the greatest immediate interest, and although concerned with the most elemental of all trainings—that in the correlated use of hand, eye and mind—are still of mediocre efficiency as factors in general education. I propose now to discuss briefly the reasons I have been able to find for this

[1] Address of the retiring president of the Botanical Society of America, delivered at Boston, December 28, 1909.

undesirable condition of a part of our scientific affairs, and to suggest, with particular reference to our own beloved science, some remedy therefor.

It will help to clarify our problem if we can come to an understanding upon certain points in the general relations of the sciences to education, the first being this—what place ought the sciences to have in education? I think we shall agree that the sciences can never, under any circumstances, hold a place in education nearly as prominent as that of the humanities. Man is not primarily a reasoning but a feeling being. As a philosopher has expressed it, "few men think at all and they but seldom." Hence the great majority of people in most part, and all people in some degree, can best be reached and influenced by studies which appeal primarily to the feelings, that is, by the humanities, while it is only a minority which can best be reached by studies appealing chiefly to the reason—that is, by the sciences and mathematics. But a minority has rights, and those to whom the sciences especially appeal, and to whom therefore they are of the higher cultural value, are just as entitled to efficient instruction in their subjects as are the majority in theirs. The sciences must always hold, from their nature in conjunction with that of humanity, a position quantitatively inferior to that of the humanities, but they are entitled to a qualitative equality of educational rank and opportunity. This they do not yet possess, and it is alike our duty and our interest to see that they shall.

A second point of importance in the general relations of the sciences to education is involved in the fact that the times themselves are a bit out of joint, educationally speaking. This is not a matter of individual opinion, but of well-nigh universal agreement. The recent addresses of our younger college presidents have united in expressing dissatisfaction with the results derived from our superb educational equipment, while the remarkable declaration of principles of the National Educational Association, issued a year and a half ago, recognizes an equivalent condition for the schools. It is a fact that our students as a whole have many hazy impressions but little exact knowledge, are habitually inaccurate even in the three r's, and have too little regard for intellectual matters. The cause of it all is obvious enough. Our education, step by step with our modern life, has become luxurized. Its features disagreeable to young people have been sedulously softened, their whims are determinants of educational programs, and the responsibility for learning has been largely shifted from them to their teachers. The wise Mr. Dooley has the modern college president say to the incoming freshman: "What branch iv larnin' wud ye like to have studied f'r ye be our compitint profissors?" and his humor as usual illumines a central kernel of truth. The trouble with our education is this, that it needs more starch; yea, it needs a bit more blood and iron. It ignores the fact that, with the mind as with the body, it is only through effort that strength can be gained, and through responsibility that character can be formed. It is not more work our students need, but work of a kind which does more to inculcate a willingness for effort, and pride in a Spartan devotion to duty—of a kind which enkindles in the heart of youth the precious spark of intellectual ambition. I would not exaggerate the defects of our present-day education. I know they do not go to the vitals, and certainly they are more serious in some places than others. But this granted, there yet remains too great a deficiency, especially in educational morale. Our col-

leges are not going to the dogs, but they certainly permit some very queer mongrels to roam at large on the campus.

Now the application of these remarks to our present problem is doubtless sufficiently plain. In an educational system which too much permits inaccuracy of work, indefiniteness of knowledge, avoidance of effort, and whimsical selection of studies—in such a system the sciences, whose essence is care, exactness, persistence and consistency, have not a wholly fair chance. One of the principal reasons, therefore, why the sciences do not loom larger in present-day education is the fault of that education and not of the sciences.

A third point of importance in the educational status of the sciences is involved in the fact that they have not as yet had time to become organized and standardized for their most effective educational use. The humanities have behind them so many generations of experience that they are now measurably standardized throughout, and offer a continuous and suitably-graded training from kindergarten to college. But the sciences as laboratory-taught subjects are not much more than a single generation old, and many of their problems are still unsettled. In the higher grades our teaching is better than in the lower, while, as everybody knows, we are still far from any consistent and continuous system of instruction in nature knowledge in the lower schools. Just here lies a great weakness of scientific education at the present day, for students too often are sent into high school and college not only without the positive advantage of good early training, but even with a prejudice against a kind of activity of which they have had little, or too often an unfortunate, experience. This condition is inevitable to the youthfulness, educationally, of the sciences, and will be remedied in time.

The last point I would mention in the educational relations of the sciences to the older subjects is this, that the sciences are under some minor disabilities from which the others are free. These center in the laboratory, and are connected in part with the fact that the laboratory type of study, with its mechanical manipulation, its fixed hours and methods of work, and its absolute requirement of independent observation, is distasteful to the great majority of persons, who, whether by natural inclination or acquired habits, prefer to absorb their knowledge in physical ease, by methods which can be lightened by the wits, and from printed books upon which they can lean for authority. Again, laboratories are expensive, much more expensive than the equipment of the other subjects. This acts as a check to the sciences all along the line, while in poorer communities it is often determinative against their introduction at all.

Now it may seem, at this point, that I have needlessly infringed on your patience and my own allotment of time in thus enumerating such obvious matters, but in truth I have had a good object, which is this: I wish to emphasize that all of these disabilities under which science-teaching now labors, these elements of our problem which are not our own fault and for the most part are beyond our control, and the list of which I have made as long as I could, —all of these taken together go only a very small way towards explaining the deficiency of the sciences in education. This deficiency, I believe, is for the most part our own fault and removable, and it all centers in this, that we are not teaching our subjects properly. And now I have reached the real theme of my present address.

Whenever we are faced by any large problem, we tend to seek its solution in some single great factor. Yet, as the phe-

nomena of our own science so often illustrate, the solution is as likely to be found in the cumulative action of several small causes, and such I believe to be true of the problem before us. These causes are some four in number, of which the first appears to be this—*we are not faithful to the genius of our subject.*

The genius of science consists in exact observation of real things, critical comparison of actual results, and logical testing of the derived conclusions. The educational value of science consists in a training in these things, and our teaching should reflect them. Yet in fact in too great part it does not. For one thing we have joined in the rush to render our subjects popular, a spirit which is one of the pernicious by-products of the elective system under which most of us work. Our subjects being elective, students will not take them unless they are made attractive: our success as teachers is largely judged by the number of students we can charm into our courses: our colleagues stand ready to cry "snap" to any course which grows faster than they can see cause for: therefore the logical procedure for the teacher is to draw great numbers but keep them complaining of the work, and he is the greatest teacher under this system who can attract so many students that a new building must be provided immediately, while their lamentations over the difficulty of the course are loud enough to reach the ears of all of his colleagues! Now this condition can be attained with quantity, though not with intensity, for most students will not elect a course involving intensive work which they can not escape, but they are willing to elect one in which the work may be eased by the wits, no matter how copious the irrigation of information may be. Just here indeed is a very fundamental trouble with our education in general. We are teaching our students to gobble when they need to be taught to fletcherize.

Another phase of our treason to the genius of science is found in the belief and practise of some teachers that broad generalizations are the true aim of elementary teaching. I know a recent elementary text-book in which the author laments that "some teachers do not yet understand the importance of imparting to beginners a general rather than a special view point." And I could cite many passages to show a belief of this and some other teachers that subject matter, accuracy in details, and other fundamental verities of science, are not important in comparison with view-points and outlooks on life and that sort of thing. In my opinion there can be no greater educational error. There is no training which American youth needs more than that in a power to acquire knowledge accurately and to work details well. Disregard for particulars and a tendency to easy generalities are fundamental faults in American character, and need no cultivation, but, instead, a rigorous correction.

Another phase of our disregard of the genius of science is found in the bad character of some of our elementary teaching. Our plant physiology in some cases is so erroneous that it is only the general badness of our teaching which saves us from the humiliation of having our errors pointed out by those we are trying to teach. Our elementary experiments ought to be conducted in the spirit of rigid control, just as carefully as in any investigation. The motto in the experimenting recommended by our text-books seems to be, "the easiest way that will give a result in agreement with the book," and we seem not to care whether that result is logically or only accidentally correct. In this spirit is the use of make-shift and clumsy appliances instead of accurate and convenient ones,

something which is justifiable only when no better can possibly be had. Such slipshod and inaccurate ways are not only wasteful of time and effort, but are actually pernicious because they inculcate a wrong habit and ideal of scientific work. I do not mean at all, here or anywhere, that young pupils should be made to study advanced scientific matters or to use technical methods, but simply that the treatment of their subjects according to their grades should be strictly scientific in spirit as far as it goes. Moreover, any attempt to avoid this spirit is the more unfortunate because needless, for as a matter of fact the great majority of young people respect exactness, and really like to be made to do things well. They do not like the process at first, and will avoid it if they can, but they like the result, and if the process be persisted in they come in time also to like that.

In a word the first great need of our science teaching is to make it scientific.

The second of the four principal causes of our inferior teaching is this, *we take more thought for our subject than we do of our students.* In the graduate teaching of a university this attitude is logical, but in college and school it is wholly wrong. I think we may express the matter thus, that any teacher who is more interested in his subject than in his students is fit only for a university. It is, I am sure, somewhat more characteristic of scientific than of other teachers that they tend to shut themselves up in their subjects, and to withdraw more than they ought from the common interests, duties and even amenities of the communities in which they live. For this, of course, the very attractiveness of science is largely responsible, because to those who have once passed the portals, science offers an interest so vastly and profoundly absorbing that all other matters appear small by comparison; and we are apt to conclude that the nobility and beneficence of such a mistress are sufficient justification for a complete immersion in her service. We forget that science has no existence apart from humanity, and no meaning unless contributory, however indirectly, to human welfare and happiness. And it should be emphasized to every young teacher that success in science teaching, as in so many other occupations, is well-nigh in direct proportion to one's ability to influence people. Our science teaching would be better if our teachers trusted less to the abounding merits of their subjects, and more to the qualities which personally influence young people—the sympathetic qualities involving interest in their pursuits, the diplomatic qualities involving the utilization for good purposes of the peculiarities of human nature, the perfecting qualities involving the amenities and even the graces of life. There is no inconsistency between these things and the preservation of the scientific quality of the teaching. It is simply a question of the presentation of science in a manner which is humanistic. It is the gloving of the iron hand of the scientific method by the soft velvet of gentle human intercourse. Science is the skeleton of knowledge, but it need lose nothing of its strength and flexibility if clothed by a living mantle of the human graces. It is idealism with realism which is demanded of the science teacher, and if some one would rise to say that this union is logically impossible I would answer, that many a problem of this life unsolvable by the subtleties of logic can be settled by robust common sense.

Of our over-neglect of the personal peculiarities of our students I know several illustrations, but have space only for one. Young people appear to have in them some measure of Nägeli's innate perfecting principle, which leads them upon the

whole to respect and like those things which are good and clean and dignified, a feeling which manifests itself in their strivings after good clothes, good society and things supposedly artistic, not to mention innumerable longings after the lofty unattainable. Now a dirty or carelessly-managed laboratory is a direct shock to this feeling, and most scientific laboratories sin in these features. I believe there is no part of a college or school equipment which ought to be prepared and managed with more care than a scientific laboratory. Efficiency for its purpose is of course the first requisite of any laboratory, but in college or high school that efficiency should be secured with attention to the utmost of pleasing effect, in the direction of a large simplicity, evidence of care for each feature, and an atmosphere of spacious and even artistic deliberation. As an example of what can be done by good taste to give a pleasing setting to the most unpromising objects, I commend the New York Zoological Park, which embodies an idea much needed in most of our botanical institutions. We ought not to permit the accumulation of dusty and disused articles around laboratories any more than around libraries: our teaching museums should contain no crowded accumulations of half-spoiled specimens in leaky green bottles, but only a selection of the most important, and those in the best of receptacles well labeled and tastefully displayed. Our experiments with plants should not exhibit dirty pots on untidy tables, but every plant should present an aspect suggestive of considerate care, while all the surrounding appliances should glitter with cleanness and stand on a spotless table widely enmargined with space and neatness. One of my friends in a neighboring college has said of the methods of my laboratory that they savor of the old maid. I take pride in this compliment, for it shows I am advancing. All of these qualities of care, neatness, concentration upon a few large and worthy things, can be made to appeal greatly to youth, as I have learned from experience. Besides, they are scientific, and they are right.

There is yet one other phase of this subject of humanism in science teaching which I wish to emphasize. I think we do not make enough use in our teaching of the heroic and dramatic phases of our science, of the biography of our great men and the striking incidents of our scientific history. I know that their use is attended with dangers, dangers of false sentimentalism, of substitution of weak imagery for strong fact, of complication with religious prejudices; and they should therefore be introduced only as the teacher grows wiser. But when the tactful teacher can employ them to touch the higher emotions of his students, he should do so. The imagination is as necessary a part of the equipment of the man of science as of the man of letters or of art, a matter which has been illuminated with all his usual skill by President Eliot in his great address on the new definition of the cultivated man. When Darwin wrote his famous passage on the loss of his esthetic faculties he was a little unfair to his science and a good deal unfair to himself. For he never mentioned the compensation he had found in the intensity of lofty pleasure derived from his acquisition of new truth. Science hath her exaltations no less than poetry, music, art or religion. Not only is the feeling of elation which comes to the scientific investigator with the dawning of new truth just as keen, just as lofty, just as uplifting as that given by any poetry, any music, any art, any religious fervor, but they are, in my opinion, the same in kind. There is but one music heard by the spirit, and that is

in us, whether it seem to come from the spheres, from the lyres of the muses, or from the voices of angels, and it gives forth when the last supremest chord in the soul of man is touched, it matters not by what hand.

We come now to the third of the causes which make our teaching of science defective, and it is this—*we put our trust too much in systems and not enough in persons.* And of this there are many evidences. For one thing we rely too much on a supposed virtue in buildings and equipment, though in this we but share the spirit of our machinery-mad day and generation. It is much easier for us Americans to obtain great laboratories and fine equipment than to make good use of them afterwards, and nowhere among us do I see any signs of a Spartan pride in attaining great results with a meager equipment. Moreover, we make a deficiency of equipment an excuse for doing nothing. As one of the most brilliant of American botanists once said, some persons think they can do nothing in the laboratory unless provided with an array of staining fluids which would make the rainbow blush for its poverty. A second evidence of our confidence in systems is found in the easy insouciance with which university professors proceed to write text-books for high schools. The only qualification the most of them have therefor is a knowledge of their subject, and they seem to regard any personal acquaintance with the peculiarities of young people, and with the special conditions of high school work, as comparatively negligible. In consequence these books are necessarily addressed to some kind of idealized student, usually a bright-eyed individual thirsting for knowledge. This kind does exist, but in minority, whereas the real student with which the high school must deal is one of a great mass willing to learn if it must. Confirmation of the correctness of my view that knowledge of students is as important as knowledge of subject for the writing of a high school book is found in the fact that the author of the botanical text-books most widely used in the high schools of this country has had only a high school experience. Another phase of our belief in the sufficiency of systems is found in the utterly unpractical character of many of the exercises or experiments proposed for the student in some of our books. These recommendations have obviously been worked out in the comfort of the study chair, and have never been actually tested in use by their suggestors; yet they are presented in a way to make the student feel that he is either negligent or stupid if he fails to work them. These theoretically constructed schemes for elementary teaching, and these recommendations of untried and impracticable tasks for students, sometimes run riot in company with sweeping denunciations of our present laboratory courses, and suggestions for their replacement by hypothetical field courses, utterly regardless of the fact that the former, whatever their faults, have been evolved in actual administrative adaptation to the real conditions of elementary work, while the proposed substitutes are wholly untried, and in the light of actual conditions, wholly impracticable.

On the other hand, there is one particular in which we have not system enough, and that is in the standardization of nature study and elementary science courses. I have already mentioned the advantage the humanities have in the approximate standardization of their instruction throughout the educational system, and towards this end for the sciences we ought to bend every effort. For one thing we should give all possible aid and comfort

to our nature-study experts in their efforts to develop a worthy system of nature study in the grades. Again, the peculiar relation of preparatory schools to colleges in this country makes it imperative that we develop standard elementary courses which any school can give with assurance that they will be accepted for entrance to any college. Happily we are here upon firm ground, for we already possess such a standard course, or unit, in that formulated by a committee of botanical teachers, now the committee on education of this society. This course is formulated upon the synthetic principle, that is, it selects the most fundamental and illuminating matters offered by the science without regard to its artificial divisions, and combines these in such manner as to make them throw most light upon one another. Its adaptability to our conditions, and its acceptability to our best educational opinion, is shown by several facts, by its adoption as the unit by the college entrance examination board which has been holding examinations upon it all over the country for six years past, by its use in innumerable high schools, by the agreement between its plan and that of all of the recent and successful text-books, by the final disappearance of all influential opposition to it, and lastly by the substantial concurrence of the unit now in formulation by the teachers of the middle west. With so firm a foundation in a plan we ought to be able to unite on perfecting details. There is no inconsistency between such standardization as this and the greatest freedom in teaching. The optical power of the microscope has not been injured by the standardization of its form and screw-threads.

I come now to the fourth of the reasons why our science teaching is defective, and that is the most vital of all. *Our method of training teachers is wrong.* I believe it is true that in general our educational advances work down from above—from university to college, from college to high school and from high school to the grades; and in a general way each of these institutions is the finishing school for teachers of the grade below. Now the work of our universities is for the most part admirable in every way, but they are not good training schools for college teachers. One of the greatest of our college presidents lately remarked that the principal obstacle in the way of making a college what it ought to be is the difficulty nowadays of securing the right kind of teachers. "We have to take them as the universities supply them," he said, "and then make them into good college teachers afterwards." The defects of the universities in this respect are two-fold. First they are training students only for their own kind of activity, in which everything centers, very properly, in research: and second, they are omitting to teach divers matters very essential for the college teacher to know.

That our universities make research the central feature and great leading method of their training of graduate students is natural, logical and correct, so far as training for their own kind of activity is concerned; but it ignores the fact that only a minority can remain in that work. The justification of the training of all by a method which is correct only for a minority is usually expressed in this form, that he is the best teacher who is an active investigator. Now if this is qualified by the proviso, "other things being equal," it is approximately true; but in fact other things very rarely are equal, and in the matter under discussion they are profoundly unequal. In my opinion the imposition upon all university students of the university research ideal is doing vast

harm to our teaching in college and therefore in high school. For one thing, it sends out ambitious young men imbued with the feeling that they must maintain their research at all costs, or else forfeit the good opinion of their teachers, the possibility of membership in the best scientific societies, and especially any chance for a call to university work, though this latter point should not be given great weight, since to a person with a liking for teaching a good college offers as attractive a career as a university. In consequence there is continual pressure on the teacher to subordinate his teaching to research. Now in college and high school this is wrong, ethically and practically. A college teacher is never engaged for research, but for a very different purpose, and it is his first duty to carry out that purpose to the very best of his ability. If there is any man who can carry on active investigation and at the same time do college or high school work as well as if he were concentrating wholly on that, the man is fortunate, and so is the institution which has him. But in fact this can rarely be true. For one thing, the limitations of time and strength prevent it in most cases; and for another, the qualities and temper required for the two activities are not only different but somewhat antagonistic. Research requires concentration, and much consecutive time fixed by the nature of the work, while the teacher must be ready for constant interruptions, and must regulate his time to fit the schedules of his students. To one immersed in the crucial stage of an investigation the little troubles of students seem absurdly trivial, if not stupid, and under their application for aid he is almost more than human if he can keep a sweet temper and not answer with repellant brusqueness. To the good teacher, the troubles of students are never trivial, but rather are welcome as means to the advancement of his particular interests. Furthermore, I believe that the research ideal imposed on all men trained in the universities is the cause not only of much injury to teaching, but of much unhappiness to teachers. For if the teacher be conscientious, and gives his first strength to his teaching, he is soon doing his research upon the ragged ends of his nerves. I venture to say that many a teacher today is wishing he could afford to abandon all attempts at abstract research and turn whole-souled to his teaching and matters connected therewith. And when, indeed, he does so, he finds his happiness and his usefulness alike immensely augmented. I know this is true, for I have been through it. It took me many long years to free myself from the feeling that I must continue research or else sacrifice the good opinion of my colleagues. But I am free, and in the two or three years I have been so the added keenness of my pleasure in my teaching, and in various activities related thereto, has been such as to make me feel like a Sinbad who has dropped his old man of the sea. And if there are any among you who believe that I stay in a society given to research only under false pretenses, I ask you to have patience a little, for I purpose to try to convince the society that its rules ought so to be altered as to make teaching, of approved merit and service, a sufficient qualification for membership. Meanwhile I advise all of my colleagues engaged in collegiate work to join in my declaration of independence. Let us show the universities that teaching hath her victories no less than research.

But now I am going to qualify a little. When I say research I mean abstract research, of the university type, the kind which has place on the skirmish line of the forefront of advancing knowledge. In

truth I agree that he is the best teacher who is also an active investigator, but I maintain that in the case of college teachers the investigation ought to have some kind of connection with the teaching. This is entirely possible, for a vast and fruitful field for research lies open in educational organization, in the introduction of more logical, useful and illuminating topics, experiments and methods, in the fitting of science better to the growing mind, in local floras and the natural history of common plants, in ways for better collation and diffusion of knowledge. After all, it is the spirit of investigation that is the matter of value to the teacher, not the results. A contemplation of the status of much of the investigation put forth by busy teachers somehow seems to suggest a saying of one of our senior botanists, who was in his youth somewhat of a botanical explorer, and always a genial wit. Apropos of the making of bread in camp he has been heard to remark that "it may not result in very good bread, but it's great for cleaning the hands." In investigation as elsewhere, results are most surely and economically won by experts, selected, trained and devoted to that work. The college teacher would do better not to waste his strength on a field in which he can be little better than an amateur, especially when there lies open another in which he can himself be an expert, and that is in educational-scientific investigation.

From this which the university ought not to do, I turn now to things which it leaves undone. It is not giving to those who are to be college teachers certain knowledge and training which are indispensable to good teaching. Thus, it does not insist that they shall know the common facts about the familiar plants around them. The old type of botanical course, consisting in the study of the morphology and identification of the higher plants, is gone forever, not because it was not good, but because the expansion of knowledge has given us something still better. Yet the knowledge involved in the old course is indispensable to every teaching botanist, and I would have a requirement made that no person could be recommended as a competent botanical teacher for a college until he had spent at least two summers of active field work on the critical study of some flora. Again, most of our university-trained teachers know nothing more of the historical or biographical phases of the sciences than they may have picked up incidentally. Yet for purposes of teaching, a knowledge of the history of the science itself, and of its relations to other great matters, is vastly important, in part for the favorable background it offers for the projection of our present-day knowledge, and in part for the purpose of placing the dramatic, heroic and humanistic aspects of the science at the disposal of the teacher. Again, the teacher may go forth from the university without any other than the most fragmentary knowledge of laboratory administration, although there is a rapidly developing technique of efficient and economical management of laboratory construction, furniture, apparatus, supplies, materials, manipulation; and the lack of any training in these is one reason why our science is so often disgraced, and our influence weakened, by slovenly botanical laboratories. Again, the teacher takes up the instruction of young people without any knowledge whatever of the results, very valuable, all imperfect though they still are, which have been won in the scientific study of the psychology of the adolescent mind. And finally he receives no training in the collation and exposition of scientific knowledge, a subject of such importance that I shall speak of it in a moment apart. Training in

investigation he also needs, of course, and that he now gets with ample efficiency. We need a standardization of preparation for college and high-school teaching of the sciences, with appropriate titles or degrees. We are as yet far enough from such a condition, but not wholly without some progress to record. For one university, Chicago, in its school of education, has a department of botany and natural history, administered, by the way, by one of our members and colleagues whose accomplishments in the past give promise of great service to come.

But now once more I wish to qualify a little. While I believe that a training in common knowledge of plants, in the history of our science, in laboratory administration, in the psychology of youth, in the collation and exposition of knowledge, as well as in investigation, is indispensable to the best botanical teaching, and should be included compulsorily in the training of botanical teachers, I do not blame the universities for not providing such instruction, nor am I sure that it is a correct or economical university function. But there is one thing of which I am sure, and it is this, that there is a place in which such training is practicable and wholly appropriate and that place is the graduate department of the college.

Just here I wish to turn aside for a moment to consider a bit more this matter of training in the collation and exposition of knowledge. The expansion of science in our day has been so vast, the literature has become so voluminous, the specialization of method and thought are so extreme, that it is becoming a serious question how the results of new research, when not of a sensational nature, can be quickly, accurately and adequately incorporated into the general mass of our knowledge and made available to the intellectual or economic uses of our race. Every scientific man has witnessed the ignoring of new truth long after its announcement, and the repetition of old error long after its disproval, not alone in popular information and literature, but even in the best scientific text-books; and this mal-adjustment between scientific research and general knowledge waxes constantly greater. The trouble is plain; we have no recognized collators of knowledge, scholars whose business it is to stand between the investigator and the general user of knowledge and to interpret correctly the results of the one to the other. The need for such service was pointed out long ago by Francis Bacon. In his prophecy of the future development of scientific knowledge, veiled under his story of "The New Atlantis," he describes the division of duty among the scholars of Salomon's House. He says:

> Then after divers meetings and consults of our whole number, to consider of the former labours and collections [an obvious prophesy of our scientific meetings], we have three that take care, out of them, to direct new experiments, of a higher light, more penetrating into nature than the former. These we call Lamps. . . . Lastly, we have three that raise the former discoveries by experiments into greater observations, axioms, and aphorisms. These we call Interpreters of Nature.

To-day we have our lamps, and their light shines steadily and benignantly forth. We call them universities. But where are our interpreters of nature? Though we need them, we have them not. They should be our colleges. In all of the great body of intellectual endeavor there is no greater weakness and no greater opportunity for service, than in the interpretation to all men of the results secured by research, not in science alone, but in other departments of knowledge as well. It is the absence of such interpreters which leaves room for the charlatans of knowledge, the mendacious reporter who uses his bit of college information to give a specious semblance of

truth to his inventions or exaggerations, and the nature fakir whose literary skill is his sole qualification. This interpretation of knowledge is no easy matter. Compilation will not do, for the interpreter must repeat observations and experiments far enough to give him a personal and familiar grasp of the materials. Nor even is a first-hand knowledge of the materials enough; he must also be able to set them forth in exposition with a combination of pedagogical clearness and literary force. So little developed is the interpretation of knowledge in comparison with its acquisition that although we have many strong journals devoted to research we have almost none devoted to interpretation and exposition. We have two or three popular journals, carried on by the devotion of loyal individuals, but with all the conditions for success against them. A suitable journal for the collation, interpretation and diffusion of botanical knowledge can only be conducted by an institution whose credit is involved in its permanence and efficiency. It should be marked by dignified form, artistic dress, and literary grace, with departments covering so completely their fields that no person with a serious interest in the science can possibly afford, and much less be willing, to be without it. Such a journal must of course be heavily subsidized, or endowed, especially at first; but there is not at present any place in the educational structure where an endowment would tell so heavily. It would be worth more to education than the endowment of any professorship that I can think of, even a professorship of botanical education in my own college. Such a journal should issue from a college, not a university. I would like to edit it, and I have the plans worked out in complete detail; but I shall not undertake it unless the business foundation can first be made secure.

Not only does the training of interpreters of nature, and of other knowledge as well, whether as teachers, as writers, through the editing of suitable journals, or other activities, seem wholly appropriate to a college, but I think it would offer the colleges themselves a mission which would react grandly on their general efficiency. There is an agreement that the first function of the college is the training of young people in the qualities which go to make more effective members of organized human society. But there is also a general feeling that somehow this is not by itself quite sufficient, for while it offers a worthy and amply difficult educational service, it does not provide a sufficiently-absorbing intellectual interest. Our colleges require, for the maintenance of high intellectual tone, both of students and of teachers, some more vigorous intellectual resistance than undergraduates alone can offer. It is in response to this feeling that some colleges have established graduate work, but in all cases, so far as I know, of the investigation or university type. For such work, however, our students should be sent to a university, which can provide far better than any college the facilities, companionship and atmosphere essential to its successful pursuit. To encourage young people, who are never well informed upon these matters and who do not understand the differences between institutions, to come to a college for work of the university type, is little better than attracting them under false pretenses. It would be much better for our educational system if the colleges would do no graduate work at all, unless they can offer something which they can do better than the university. In the training of their own and high-school teachers, and other interpreters of knowledge, they have, from the very nature of their activities and the presence right at hand of the best of all practise

schools, a work which they can do better than the university. I hope ere long to see, in one of our greater colleges, the establishment of the first graduate school devoted to the training of these interpreters of knowledge.

But now I have reached the bounds which custom and courtesy allow to a speaker for this kind of address, and although I think with regret of the many large matters I fain would include to make my account of this subject complete, I must come to a close. I shall add but one thing, which is this—a summary of the objects for which we should work.

1. A continuous and adequate system of nature study in the schools, so complete and so good as to send every student into the high schools with no prejudice against science, and with a solid foundation of natural fact knowledge.

2. A four-years' course in the high school in the standard sciences, upon exactly the same basis of efficient teaching and educational dignity as any other subjects whatever, being required in so far as they are required, and elective in so far as they are elective.

3. A system of education in the college which will preserve the golden principle of the elective system—viz., the fact that the mind like the body derives greater good from an exercise in which it can take an interest than from one in which it does not—while pruning away the absurdities that have been allowed to graft themselves thereon. The logical system is the group system, in which the student is free to choose his group, but having once chosen it, finds his studies arranged on a plan approved as wise by educational experience. We must not expect a majority ever to choose the science groups, but those who do should receive a training qualitatively equal to that in any subjects whatever, and, above all, thoroughly but humanistically scientific.

4. A critical review and retesting of our present educational methods and material, with a view to the elimination of the impracticable, the replacement of the mediocre, and the introduction of better, to be sought through critical educational research.

5. A system of training of teachers which shall recognize that college teachers and university investigators are not one and the same, but fellow craftsmen, entitled to equal honor for equal achievement. The training of the university investigator belongs to the university, but of the college teacher to the college, which should establish the suitable instruction in the practical and humanistic phases of the subject. And since the college teacher is from his profession primarily an interpreter of knowledge, he should make that his particular field; and the colleges should cherish and develop, as their particular function, all activities connected therewith.

These things, I believe, will make the sciences free from their present educational disabilities. It is true they will not give us perfection. But what is perfection, and who wants it? Perfection, so I fancy, for I never have seen it, is in this like truth, that there is more pleasure in seeking than in finding it. Besides, man, for whom we are doing it all, is imperfect, though the extent thereof depends upon the point from which we view him. If one were to look down upon him from the place of the angels towards which he likes to believe he is ascending, he must seem a very poor creature, deserving only of pity. But if one looks up after him from the place of the beasts from which we know he has risen, then he looms as a very grand figure, worthy of credit and honor. After all, perfect or imperfect, good, bad or indif-

ferent, he is the very best thing of which we are sure. It behooves us, therefore, to make the most of him.

W. F. GANONG

SMITH COLLEGE

PRESENTATION OF THE LANGLEY MEDAL TO THE WRIGHT BROTHERS[1]

Mr. Chancellor: The award of the Langley medal to the Brothers Wilbur and Orville Wright emphasizes the fact that we are living in an age of great achievements.

The twentieth century had hardly dawned when the world was startled by the discovery of radium, which has opened up an entirely new field to science, and which has led us to modify profoundly our conceptions regarding the constitution of matter.

Another new field has been revealed to us through the development of wireless telegraphy and telephony; and we now utilize the vibrations of the ethereal medium of space for the transmission of thought.

Then again, we may note the most revolutionary changes going on before our eyes relating to methods of transportation.

The appearance of the hydroplane-boat probably foreshadows a revolution in marine architecture and propulsion. On land we see motor-cycles, automobiles and electric cars displacing the horse. Petroleum and electricity have become powerful rivals of steam; and we seem to be on the eve of a revolution in our methods of railroad transportation, through the application of the gyroscope to a monorail system. And now aerial transport has come, dispensing with rails and roads altogether. The air itself has become a highway; and dirigible balloons and flying machines are now realities.

[1] Historical address by Dr. Alexander Graham Bell at the Smithsonian Institution, February 10, 1910.

How well the predictions of Langley have been fulfilled. We now recognize that he was right, when he said a few years ago (1897) that:

> The world, indeed, will be supine if it do not realize that a new possibility has come to it, and that the great universal highway overhead is now soon to be opened.

It has been opened; and who can foretell the consequences to man?

One thing is certain: that the physical obstacles to travel have been overcome; and that there is no place on the surface of the globe that is inaccessible to civilized man, through the air.

Does this not point to the spread of civilization all over the world; and the bringing of light to the dark continents of the earth?

THE PIONEERS OF AERIAL FLIGHT

Who are responsible for the great developments in aerodromics of the last few years? Not simply the men of the present, but also the men of the past.

To one man especially is honor due—our own Dr. S. P. Langley, late secretary of the Smithsonian Institution. When we trace backwards the course of history we come unfailingly to him as *the great pioneer of aerial flight.*

We have honored his name by the establishment of the Langley medal; and it may not be out of place on this, the first occasion for the presentation of the medal, to say a few words concerning Langley's work.

LANGLEY'S WORK

Langley devoted his attention to aerodromics at a time when the idea of a flying machine was a subject for ridicule and scorn. It was as much as a man's reputation was worth to be known to be at work upon the subject. He bravely faced the issue, and gave to the world his celebrated

memoir entitled, "Experiments in Aerodynamics."

In this work he laid the foundations for a science and art of aerodromics; and raised the whole subject of aerial flight to a scientific plane.

The knowledge that this eminent man of science believed in the practicability of human flight gave a great stimulus to the activities of others, and started the modern movement in favor of aviation that is such a marked feature of to-day.

Every one now recognizes the influence exerted by Langley on the development of this art. The Wright Brothers too have laid their tribute at his feet. They say:

The knowledge that the head of the most prominent scientific institution of America believed in the possibilty of human flight was one of the influences that led us to undertake the preliminary investigations that preceded our active work. He recommended to us the books which enabled us to form sane ideas at the outset. It was a helping hand at a critical time, and we shall always be grateful.

CONTRIBUTIONS TO THE SCIENCE OF AERODROMICS

Langley's experiments in aerodynamics gave to physicists, perhaps for the first time, firm ground on which to stand as to the long-disputed questions of air resistances and reactions. Chanute says:

(*a*) They established a more reliable coefficient for rectangular pressures than that of Smeaton.

(*b*) They proved that upon inclined planes the air pressures were really normal to the surface.

(*c*) They disproved the "Newtonian Law," that the normal pressure varied as the square of the angle of incidence on inclined planes.

(*d*) They showed that the empirical formula of Duchemin, proposed in 1836 and ignored for fifty years, was approximately correct.

(*e*) That the position of the center of pressure varied with the angle of inclination, and that on planes its movements approximately followed the law formulated by Joessel.

(*f*) That oblong planes, presented with their longest dimension to the line of motion, were more effective for support than when presented with their narrower side.

(*g*) That planes might be superposed without loss of supporting power if spaced apart certain distances which varied with the speed.

(*h*) That thin planes consumed less power for support at high speeds than at low speeds.

The paradoxical result obtained by Langley that it takes less power to support a plane at high speed than at low, opens up enormous possibilities for the aerodrome of the future. It results, as Chanute has pointed out, from the fact that the higher the speed, the less need be the angle of inclination to sustain a given weight, and the less therefore the horizontal component of the air pressure.

It is true only, however, of the plane itself; and not of the struts and framework that go to make up the rest of a flying machine. In order therefore to take full advantage of Langley's law, those portions of the machine that offer head resistance alone, without contributing anything to the support of the machine in the air, should be reduced to a minimum.

CONTRIBUTIONS TO THE ART OF AERODROMICS

After laying the foundations of a science of aerodromics, Langley proceeded to reduce his theories to practise.

Between 1891 and 1895 he built four aerodrome models; one driven by carbonic acid gas, and three by steam engines.

On May 6, 1896, his "Aerodrome No. 5" was tried upon the Potomac River near Quantico. I was myself a witness of this celebrated experiment; and secured photographs of the machine in the air, which have been widely published.[3]

This aerodrome carried a steam engine, and had a spread of wing of from twelve to fourteen feet. It was shot into the air from the top of a house-boat anchored in a quiet bay near Quantico.

[3] A photograph of this flight was here shown.

It made a beautiful flight of about 3,000 feet, considerably over half a mile. It was indeed a most inspiring spectacle to see a steam engine in the air flying with wings like a bird. The equilibrium seemed to be perfect, although no man was on board to control and guide the machine.

I witnessed two flights of this aerodrome on the same day; and came to the conclusion that the possibility of aerial flight by heavier-than-air machines had been fully demonstrated. The world took the same view; and the progress of practical aerodromics was immensely stimulated by the experiments.

Langley afterwards constructed a number of other aerodrome models which were flown with equal success, and he then felt that he had brought his researches to a conclusion, and desired to leave to others the task of bringing the experiments to the man-carrying stage.

Later, however, encouraged by the appreciation of the War Department, which recognized in the Langley aerodrome a possible new engine of war, and stimulated by an appropriation of $50,000, he constructed a full-sized aerodrome to carry a man.

Two attempts were made, with Mr. Charles Manley on board as aviator, to shoot the machine into the air from the top of a house-boat; but on each occasion the machine caught on the launching ways, and was precipitated into the water. The public, not knowing the nature of the defect which prevented the aerodrome from taking the air, received the impression that the machine itself was a failure and could not fly.

This conclusion was not warranted by the facts; and to me, and to others who have examined the apparatus, it seems to be a perfectly good flying machine—excellently constructed, and the fruit of years of labor. It was simply never launched into the air, and so has never had the opportunity of showing what it could do. Who can say what a third trial might have demonstrated. The general ridicule, however, with which the first two failures were received prevented any further appropriation of money to give it another trial.

CONCLUSION

Langley never recovered from his disappointment. He was humiliated by the ridicule with which his efforts had been received; and had, shortly afterwards, a stroke of paralysis. Within a few months a second stroke came, and deprived him of life.

He had some consolation, however, at the end. Upon his death-bed he received the resolution of the newly formed "Aero Club of America," conveying the sympathy of the members, and their high appreciation of his work.

Langley's faith never wavered, but he never saw a man-carrying aerodrome in the air.

His greatest achievements in practical aerodromics consisted in the successful construction of power-driven models which actually flew. With their construction he thought that he had finished his work; and, in 1901, in announcing the supposed conclusion of his labors he said:

> I have brought to a close the portion of the work which seemed to be specially mine—the demonstration of the practicability of mechanical flight—and for the next stage, which is the commercial and practical development of the idea, it is probable that the world may look to others.

He was right, and the others have appeared. The aerodrome has reached the commercial and practical stage; and chief among those who are developing this field are the brothers Wilbur and Orville Wright. They are eminently deserving of

the highest honor from us for their great achievements.

I wish to express my admiration for their work; and believe that they have justly merited the award of the Langley medal by their magnificent demonstrations of mechanical flight.

MEMORIAL TO THE LATE MORRIS KETCHUM JESUP[1]

Members of the American Museum of Natural History: We commemorate this afternoon the founding of the museum in 1869. For their services to our city and country we pay our tribute to the first presidents, John David Wolfe and Robert L. Stuart, and especially to the third president, Morris Ketchum Jesup, distinguished by his long and eventful administration.

As the oldest institution of the kind in the city of New York we welcome representatives of our twin sister, the Metropolitan Museum of Art, of our younger companions the Public Library, the Brooklyn Museum, the Zoological Park, the Aquarium and the Botanical Garden—all animated by the same purpose, all under a similar government, and together forming a chain of free educational institutions of which the city may well be proud.

We are honored by the presence of delegates from the president of the United States, from the governor of this state, from several of the great American universities and national institutions of scientific research.

The leading officers of the city government and of the board of education are present. His honor, the mayor, the president of the park department and the comptroller are members of our board. It is significant that these heads of the second great municipality of the world are uniting with us to play the part of hosts in this celebration, because the city and trustees have enjoyed from the first a free and cordial union. From their entire community of purpose there is no reason why they should ever disagree. Through the original application of the museum for land, this institution is legally under the department of parks, but although the relation is amicable and effective, the museums are less a part of public recreation than of the great civic system of education.

A few words may be said as to the kind of educational spirit which has been developed under past administrations and will be increasingly developed in the coming years in other branches of science. They are words as to our future. We believe that we are only on the threshold of the applications of science, or knowledge of the laws of nature as they bear on human morals, welfare and happiness. If there is one new direction which this museum shall take it is in the applications of science to human life. Here people shall have a vision not only of the beauty, the romance, the wonder of nature, but of man's place in nature, of laws as inexorable as the moral commands of God handed down by great religious teachers. Over the portals of our new hall of public health we may well place the inscription, "Learn the Natural Commandments of God and Obey Them." If nature is stern and holds in one hand the penalty for violation of her laws, she is also gentle and beneficent and holds in the other hand the remedy, which it is the duty of science to discover and make known.

What is the part the museum exhibition halls should play in this teaching? An ideal museum is a mute school, a speechless university, a voiceless pulpit; its sermons are written in stones, its books in the life of the running brooks; every specimen, every exhibition, every well-arranged hall

[1] Address of Henry Fairfield Osborn at the celebration of the forty-first anniversary of the American Museum of Natural History.

speaks for itself. In this sense, in its appeal to the eye, in its journeys for those who can not travel, the museum is not the rival, but the helpful ally of all the spoken methods of instruction within its own walls and throughout the great city.

Now a few words as to our past. We owe the rise of public spirit in this city and country to the war for the union; that terrible experience brought men and women of all classes together in a closer sympathy, into a new and great union. Thus Lincoln was our prophet at Gettysburg when he said, "This nation under God shall have a new birth of freedom." As will be fully told by the historian of the day, the inspiration to build a free museum for the people of this city came to us through Albert S. Bickmore. Under his scientific guidance and that of Daniel Giraud Elliot the right direction was taken. Both of these men are happily with us in this hall to-day.

The founders of 1869, whose names have recently been inscribed on yonder wall, voiced the public spirit of their day. New York was a relatively small and relatively poor city. It was before the era of the great captains of industry, of the single-handed patrons of art, science and education; nor were there any models on which to draw the lines or to take the scale, there was no British Museum of Natural History, there was no National Museum of the United States. We marvel the more at the audacity of the trustees who conceived a museum so great and who in 1874 approved a general plan larger than that of any building in the world even to the present day, larger than the Escorial of Spain or the National Capitol of Washington. It crowns this occasion that four of the originators of the museum are with us, two of its scientific advisers, two of its founders.

If I were asked which of the founders contributed most to administration and development I would say unquestionably Mr. Jesup, Mr. Morgan and Mr. Choate. Of the splendid services of our late president is it not delightful that Mr. Choate himself is here to speak?

Our two founders are here, *mirabile dictu*, as young or younger than they were forty years ago. If youth is measured by energy, by productiveness, by patriotism, these founders are two of the very youngest men in the city of New York, as each day brings forth fresh surprising and ever-welcome proofs. Who among the so-called younger generation can equal Mr. Morgan, who has quietly, and almost unknown to the public, sustained the successive administrations of Wolfe, Stuart and Jesup with his loyalty, his time, his advice, his noble gifts, and who stands behind the present administration with undiminished force and generosity.

Are not our very bones founded in the law? In the early years Mr. Choate rendered incomparable and lasting service not only to the two museums, but to the city, in laying down our charter relative to that union of public and private responsibility and beneficence which has been the model on which all the other institutions of the kind in this city have been founded, which has proved by experience to be a perfect union, for it has given the city of New York something far superior either to the publicly administered institutions of foreign cities or the privately owned and privately administered institutions of other great American cities. The essence of this charter and constitution is that from the beginning the city officials as the elective representatives of the people undertake to give the land, the building, the maintenance; the trustees volunteer to give their best ability and their valuable time to administration, their means and that of others to

filling the building with collections. The agreement has been kept on both sides in the best spirit. To the honor of the city of New York be it said that her rulers have never withheld funds from education, neither have her citizens been lacking in generosity. Owing to this peculiarly American and altogether ideal union of public and private endeavor we discover that at the end of forty-one years the amount which the people of the city of New York have contributed to this museum is balanced by an equal amount given by officers, trustees and other friends.

I have therefore great pleasure in introducing as the orator of the day the Honorable Joseph H. Choate, founder, and author of the laws of our being.

THE FOURTH ANNUAL REPORT OF THE CARNEGIE FOUNDATION[1]

THE Fourth Annual Report of the President of the Carnegie Foundation, like the three preceding reports, deals not only with the current business incident to the conduct of the retiring allowance system, but takes up also the discussion of questions dealing with educational history and educational policy. Some of these subjects are of immediate interest, such as politics in state institutions, agricultural education, college advertising, the function of the college trustee, the articulation of high school and college, and the like.

During the year the foundation granted 115 pensions amounting to $177,000. It is now paying 318 pensions, the cost being $466,000. The professors receiving these pensions come from 139 colleges, distributed over 43 states of the Union and provinces of Canada. To the accepted list of colleges, that is, to the list whose professors may regularly receive pensions under fixed rules as a right and not as a favor, seven colleges were admitted during the year. These were Coe College in Iowa, Swarthmore College in Pennsylvania, the state universities of Wisconsin, Michigan, Minnesota and Missouri and the University of Toronto. The governors and legislatures of these states asked for this privilege for their universities.

The governors and legislatures of 26 other states asked that their universities should also be admitted to the foundation. The fact that only five state institutions, one of these in Canada, have been admitted to the Carnegie Foundation, after a year of administration of the rules under which tax-supported colleges and universities become eligible, testifies to the scrutiny exercised in the admission of institutions. As the president explains in his report, the names of certain well known institutions do not appear. This means that some question has arisen in the examination of these institutions which made the trustees feel that it is necessary to wait—such, for example, as the articulation of the institution with three-year high schools, or its failure to maintain entrance requirements, or the maintenance of a weak school of law or medicine below the standards of law and medical departments of stronger institutions.

The report shows, also, that two institutions retired from the accepted list: Randolph-Macon Woman's College, which withdrew after deciding that the election of trustees must be approved by a Methodist Conference, and the George Washington University whose connection with the foundation was ended by the action of the foundation. The reasons stated are that the university had impaired its endowment and that two professors had been arbitrarily dismissed. There are now 67 institutions on the accepted list.

The second section of the report is devoted to an examination of the working of the rules for retirement as shown in the experience of the past four years. The president gives in this connection a summary of a statement from each teacher now upon the retired list as to the reasons for his retirement. As a result of the experience, two changes were made in the rules by the trustees: one extends the benefits of the retiring allowance system so that service as an instructor shall count toward the earning of a retiring allowance. Heretofore

[1] Statement supplied by the foundation.

only service in the rank of professor was counted toward an allowance. The other change makes retirement after twenty-five years of service possible only in the case of disability unfitting the teacher for active service. Except in the case of such disability, the teacher can, under the rules as now framed, claim a retiring allowance only upon attaining the age of sixty-five. Formerly a professor might retire after twenty-five years of service. This change in the rules, does not, however, deprive the widow of a teacher who has had twenty-five years of service of her pension. The action was taken in view of the fact that many men were willing to retire from the position of teachers and go into business, or because they were tired of teaching, or for other reasons entirely foreign to those for which the rule was intended to provide. Only a small minority of those retiring under 65 years of age did so because of ill health.

The third section of the report is devoted to tax-supported institutions. It states in detail the reasons which have governed the trustees of the foundation in dealing with state institutions. Agricultural education and the agricultural college are also treated at length. The trustees make clear their intention to ask of the institutions of every state whether the university and the college of agriculture are competing or cooperating parts of a state system of education. The low standards and general demoralization resulting from the competition of these two types of tax-supported institutions in the various states are definitely pointed out.

The fourth section of the report is devoted to educational administration, and deals with such subjects as financial reports, college advertising, which has in many institutions developed to formidable proportions, the function of the college trustee and other administrative topics. The problems here taken up are those of immediate practical significance in the operation of colleges and universities. The foundation announces that it will distribute within a short time a bulletin suggesting a simple form of treasurer's report which it hopes may obtain general use. It is noteworthy that only a small proportion of the colleges and universities calling on the public for support print a straightforward financial statement showing what they do with the money collected from the public. An analysis is here given of the duties of the college trustee and the importance of choosing men who will perform these duties.

The fifth section of the report is occupied with more distinctly educational problems, such as the articulation of high school and college, the weighting of college entrance requirements in favor of the classics, the relative value of educational criticism and educational construction. The whole effort in this part of the report, as in former reports, is to urge upon all the colleges in the country, whether state controlled or privately endowed, the necessity of articulation with the state system of education. In this section, also, the president takes up the statement which has been made in several quarters that the foundation might become an arbitrary force in education, and shows that the real power of the foundation is dependent upon its fair discussion of educational issues. The amount of money in the hands of the foundation is insignificant compared with the college endowments themselves, and the president insists that its most substantial asset comes from a fair, impartial and public handling of educational questions.

Following the report of the president is the report of the treasurer. In this matter the foundation has followed the advice which it gives to other institutions and prints a detailed statement, showing not only the larger items of expense, but even the individual salaries which are paid.

The report may be obtained by writing to The Carnegie Foundation, 576 Fifth Avenue, New York City.

SCIENTIFIC NOTES AND NEWS

Dr. J. D. Van der Waals, professor of experimental physics in the University of Amsterdam, has been elected a foreign associate of the Paris Academy of Sciences.

DR. S. WEIR MITCHELL celebrated his eightieth birthday on February 15. On the following day he gave a lecture before the College of Physicians of Philadelphia on "William Harvey, the Discoverer of the Circulation of the Blood."

A TESTIMONIAL banquet will be tendered Dr. William H. Welch, of Johns Hopkins University, on April 2. Gold portrait medallions of Professor Welch will be presented to him, and to the Johns Hopkins University and the Medical and Chirurgical Faculty of Maryland.

THE Italian Royal Geographical Society has conferred a gold medal on Commander Robert E. Peary, a silver medal on Captain Robert A. Bartlett, a gold medal on Lieutenant Ernest H. Shackleton and a silver tablet on the Duke of the Abruzzi for his expedition to the Himalayas. Professor W. M. Davis, of Harvard University, was made a correspondent of the society.

PROFESSOR G. H. F. NUTTALL, F.R.S., Quick professor of biology in the University of Cambridge, has been awarded the Mary Kingsley medal by the Liverpool School of Tropical Medicine.

DR. JOHN M. COULTER, professor of botany in the University of Chicago, has been elected president of the Illinois Academy of Science.

M. GURBAIN, of the University of Paris, has been elected president of the French Society of Physical Chemistry.

MR. JAMES E. HOWARD has been appointed an engineer physicist in the U. S. Bureau of Standards.

THE University of Pennsylvania has conferred its doctorate of science on Mr. Samuel Rea, third vice-president of the Pennsylvania railroad and Mr. George S. Webster, chief of the Bureau of Surveys of the City of Philadelphia.

THE officers of the Washington Academy of Sciences for 1910 are: *President,* C. D. Walcott; *Vice-presidents*—Anthropological Society, Walter Hough; Archeological Society, Mitchell Carroll; Biological Society, T. S. Palmer; Botanical Society, David White; Chemical Society, H. W. Wiley; Engineers' Society, B. R. Green; Entomological Society, A. D. Hopkins; Foresters' Society, Gifford Pinchot; Geographic Society, Henry Gannett; Geological Society, F. L. Ransome; Historical Society, J. D. Morgan; Medical Society, Louis Mackall; Philosophical Society, R. S. Woodward; *Corresponding Secretary,* Frank Baker; *Recording Secretary,* Bailey Willis; *Treasurer,* Arthur L. Day; *Additional Managers,* L. O. Howard, O. H. Tittmann, B. W. Evermann, L. A. Bauer, C. H. Merriam, C. F. Marvin, Geo. M. Kober, F. V. Coville, E. W. Parker.

A COURSE of three lectures on "Amphioxus" was given at the Imperial College of Science and Technology, Royal College of Science, South Kensington, by Professor E. W. Macbride, D.Sc., LL.D., F.R.S., February 14, 21 and 28.

FOUR lectures on "The Anatomy and Relationships of the Negro and Negroid Races" were delivered at the Royal College of Surgeons by Professor Arthur Keith, conservator of the museum, on February 14, 16, 18 and 21.

THE Julius Thomsen memorial lecture of the Chemical Society, London, was delivered on February 17 by Sir Edward Thorpe.

IN memory of the late Dr. Ludwig Mond's scientific eminence and his generous benefaction of £3,000 towards the building of the Institute of Physiology at University College, London, the college committee has resolved to name the biochemistry research department of the institute "The Ludwig Mond Biochemistry Research Laboratory."

DR. CHARLES R. BARNES, professor of plant physiology at the University of Chicago and eminent for his contributions to this subject, one of the editors of the *Botanical Gazette,* president of the Botanical Society of America in 1903 and vice-president of the American Association for the Advancement of Science in 1899, died on February 24, at the age of fifty-one years.

DR. AMOS EMERSON DOLBEAR, for thirty-two years professor of physics at Tufts College, the author of numerous contributions to phys-

ics and an inventor of distinction, died on February 23, at the age of seventy-three years.

PROFESSOR J. EDMUND WRIGHT, associate professor of mathematics in Bryn Mawr College, died on February 20 of heart disease. He was an Englishman and won distinguished honors at the University of Cambridge, being senior wrangler in 1900, first in the second part of the mathematical tripos in 1901, and Smith's prizeman in 1902, and has been for the past seven years a fellow of Trinity College, Cambridge. He was called to Bryn Mawr College in 1903 to succeed Professor Harkness, now professor of mathematics in McGill University. He was the author of numerous papers dealing with a wide range of subjects in the field of higher mathematics, such as the theory of groups, Abelian theta functions, and differential geometry of space. In 1908 his treatise on "Invariants of Quadratic Differential Forms" was published by the Cambridge University Press.

MR. WILFRED STALKER, member of the British Ornithologists' Union to Dutch New Guinea, has been drowned. Mr. Stalker, who was only thirty-one years of age, had displayed much ability as a collecting naturalist.

THE death is announced of Dr. W. Krause, docent in anatomy at Berlin.

THE French Association for the Advancement of the Sciences will hold its thirty-ninth annual meeting at Toulouse in August under the presidency of M. Gariel, professor of biological physics in the faculty of medicine of the University of Paris.

THE Blue Hill Meteorological Observatory, in Milton, Mass., founded and maintained by Professor A. Lawrence Rotch, has just completed twenty-five years' work. The initial investigations of the upper air, undertaken there in the interest of pure science, are now of practical value to aeronauts and aviators.

THE division of physical sciences of the Royal Academy of Bologna calls attention to an international competition for a biennial prize of three thousand lire established from the income of a donation made by one of its corresponding members, Professor Elia De Cyon, with the object of promoting researches in the subjects in which he has worked. This award will be conferred on competitors whose works treat: (1) The functions of the heart, and, above all, of the cardiac and vaso-motor nervous systems; (2) the functions of the labyrinth of the ear; (3) the functions of the thyroid glands of the hypophyses and of the pineal gland. The first prize will be awarded on March 1, 1911.

THE first ordinary meeting of the society formed by the amalgamation of the Society of Engineers and the Civil and Mechanical Engineers' Society, was held in London on February 7, when Mr. Diogo A. Symons, the first president of the new society of engineers, delivered an inaugural address.

THE Royal Meteorological Society held a meeting at the physical laboratory, Manchester University, on February 23. This meeting was the first the society has held out of London. Papers were read describing the investigations made at the Howard Estate Observatory, Glossop, into the electrical state of the upper atmosphere, and also on the hourly registering balloon ascents which were made from Manchester on June 2–3, 1909. Mr. Lempfert and Mr. Corless will also contribute a paper on "Line-squalls and Associated Phenomena."

ACCORDING to a communication made on February 14 to the Paris Academy of Sciences by M. Lippmann and reported in the London *Times*, Mme. Pierre Curie, the widow of M. Pierre Curie, the discover of polonium and radium, has at last succeeded in isolating one tenth of a milligram of polonium. In order to obtain this result Mme. Curie, working in cooperation with M. Debierne, has had to treat several tons of pitchblende with hot hydrochloric acid. The radio-active properties of polonium turn out to be far greater than those of radium. It decomposes chemically organic bodies with extraordinary rapidity. When it is placed in a vase made of quartz, which is one of the most refractory of substances, it cracks the vessel in a very short

time. But a no less distinctive quality of polonium is the comparatively rapid rate at which it disappears. Whereas it takes one thousand years for radium to disappear completely a particle of polonium loses 50 per cent. of its weight in 140 days. The products of its disintegration are helium and another body, the nature of which has not yet been ascertained, but Mme. Curie and M. Debierne are inclined to believe it to be lead. Its identity, however, will shortly be established, and at the same time science will have had the experimental proof of the transformation of a body which had been believed to be elementary.

A COURSE of nine illustrated lectures upon science and travel has been arranged by the Field Museum of Natural History at the Art Institute for Saturday afternoons in March and April, at three o'clock, as follows:

March 5—"Snapping Live Game on the Roosevelt Hunting Trail," Mr. A. Radclyffe Dugmore, New York City.

March 12—"The Call of the West," Mr. C. J. Blanchard, Statistician, U. S. Reclamation Service.

March 19—"Mongolia and Siberia," Professor Roland B. Dixon, Harvard University.

March 26—"Our Forests and What They Mean," Dr. Charles F. Millspaugh, curator, Department of Botany.

April 2—"Cliff Dwellers and Pueblos," Mrs. Gilbert McClurg, regent general, The Colorado Cliff Dwellers Association.

April 9—"Some Alaskan Glaciers," Professor U. S. Grant, Northwestern University.

April 16—"Fossil Hunting," Mr. E. S. Riggs, assistant curator, Division of Paleontology.

April 23—"Human Development and Evolution," Dr. Frank R. Lillie, University of Chicago.

April 30—"The Colorado River," Professor O. C. Farrington, curator, Department of Geology.

WE learn from the *Journal* of the American Medical Association that the first biennial meeting of the Far-Eastern Association of Tropical Medicine is to be held in Manila, March 5–14, 1910. The association was established with the idea of bringing together workers in tropical medicine in that part of the world, and is important in that it brings English-speaking scientific workers together for mutual social and scientific improvement. The sessions in Manila will be held in the new building of the Philippine Medical School near the Bureau of Science and the new Government Hospital. The sessions in Baguio will be held in one of the government buildings. The government has appropriated a liberal sum for entertainment of guests during the meeting. Visits have been arranged to points of interest in the neighborhood. The museums of the Bureau of Science and of the Philippine Medical School will be thrown open and demonstrations of the specimens will be given. There will be a commercial exhibit of remedial appliances and medical equipment appropriate for use in the tropics.

PRESIDENT DAVID STARR JORDAN, of Stanford University, has addressed to President Charles R. Van Hise, of the University of Wisconsin, the following letter:

Will you permit me a word in regard to reform in football? I believe that no reform worth consideration is possible so long as the game allows the play known as "interference," by the legalization of which the Rugby Game was some twenty years ago perverted into the "American Game." As results of the legalization of "offside play" or "interference," forbidden in Rugby, we have the four most objectionable features of the American Game, (*a*) mass play and "downs," (*b*) low tackling in the open field, (*c*) play directed to break down individuals of the opposite side, (*d*) the domination of professional coaches, whose interests are wholly at variance with those of the university.

In 1904, at the height of the football obsession in California, the presidents and committees on athletics of the two universities notified the students that no form of football having mass play would be again permitted. The students then adopted the Rugby game. It has been tested for five seasons, and it is wholly satisfactory to all concerned. The game demands a much higher grade of skill and alertness. It is far more interesting to watch. It is interesting to the players. It is a sport and not a battle. As with baseball, so with Rugby, each player must know the game. It is played not in armor, but in cotton knee-breeches, and there have been in five years no injuries of any consequence.

The game is now played in the universities and colleges of California and Nevada. It attracts (perhaps unfortunately) larger numbers of spec-

tators than the old game ever did. It is now played in most of the leading high schools of California. It is firmly and permanently established on the Pacific Coast, unless, as in the East, it is modified to suit the purposes of professional coaches. It seems to me that our experience in California should be worth something to our colleagues in the East.

Very truly yours,

David Starr Jordan

UNIVERSITY AND EDUCATIONAL NEWS

The medical school of the University of Pennsylvania has been given $100,000 by an unnamed alumnus to endow a chair to be known as "the Benjamin Rush professorship of physiological chemistry."

The valuable library on mathematics and science of the late Oren Root, for many years professor of mathematics at Hamilton College, has been presented to the college by his son, Mr. Elihu Root.

The dedication of three new engineering buildings at the University of Kansas occurred on February 25. The buildings are those provided for by the legislature of 1907, and are a general engineering building, housing the departments of civil and mechanical engineering and, as a temporary matter, the department of electrical engineering; a mining and geology building, and the mechanical laboratory and power plant. In the afternoon, at 2:30, addresses were given by Dean Frank O. Marvin, Dr. Richard C. Maclaurin, president of the Massachusetts Institute of Technology, and Mr. Ernest R. Buckley, president of the American Mining Congress. Following these were the dedication ceremonies, under the direction of Chancellor Frank Strong. In the evening a banquet was held at Robinson Gymnasium, with after-dinner speeches.

The Dutch government has appropriated $100,000 for a laboratory of physical and mineral chemistry at Groningen, where Professor F. M. Jaeger is head of the department.

Dr. Bertram E. Boltwood has been elected professor of radio-chemistry in the graduate school of Yale University.

Professor Seitaro Goto has been called to the chair of zoology at the Tokyo Imperial University to succeed the late Professor Kakichi Mitsukuri. Naohide Yatsu, Ph.D. (Columbia), has been appointed assistant professor. Katashi Takahashi, Ph.D. (Chicago), has been appointed to the professorship of zoology at the First High School to fill the vacancy caused by the resignation of Professor Goto.

DISCUSSION AND CORRESPONDENCE

A SUBSTITUTE FOR CROSS WIRES IN THE SPECTROSCOPE

To the Editor of Science: Should any of the readers of Science be in possession of spectroscopes which are unprovided with cross wires, it may interest them to learn of a cheap method of supplying a substitute for such desirable articles, which has been found of service in this laboratory, and which, so far as the writer knows, has not hitherto been published.

The method consists in inserting, either in the ocular, or telescope tube, at the proper focal point, a thin glass disc on which is etched a cross with lines about as heavy as the wires in an ordinary cross wire eyepiece. This cross, when in focus, appears as perfectly opaque lines, which fully answer the purpose of cross wires.

These discs have been in use here for some time, and their working has been compared with that of the regular cross wire eyepieces without any difference between the two being noticed. In fact, the cross wires of one of our instruments being somewhat too heavy, we removed them, and substituted a ruled disc with manifest gain in ease of working. The glass disc does not seem to obscure any portion of the spectrum; all portions, both of emission and absorption spectra, having been observed therethrough with instruments of various powers, both prism and grating, without any appreciable loss of either brightness or definition.

For observing a bright line spectrum it is

advantageous to have one of the cross lines made shorter than the width of the spectrum. The disc is then so placed in the instrument that this short line is vertical, and hence parallel with the spectrum lines. Under such circumstances, when this short vertical cross line is placed over a bright spectrum line, the latter is seen extending above and below it, and the small dark *ends* of the cross line being thus brought prominently in view, materially assist in marking the spectrum line upon which they are placed. The horizontal arms of the cross are, in this case, of no particular advantage in marking the spectrum lines, but they facilitate the finding of the optic axis of the telescope, and, where the instrument is provided with an illuminated scale, help to align the same. It is best to so place the scale that one end of the short vertical line reaches about the middle thereof.

Various devices may be employed to fix the disc in the spectroscope. If the instrument is provided with a negative ocular, the disc may be placed against the diaphragm, and held in position by a spring wire. It is well in that case to provide the ocular with a sliding eye lens, which can be cheaply done by any good brass worker. If the instrument has a positive ocular and a diaphragm in it, or in the telescope tube, the disc may, as before, be laid against the diaphragm, and if such is in the telescope tube, focused by sliding the ocular, or if that be fixed, the diaphragm may be moved till the cross lines are in focus. Where there is a positive ocular and no diaphragm, as is the case with some instruments, the disc may be cemented to a brass ring of proper diameter to fit snugly inside the telescope tube, and the proper position having been found, the ring can be so set that the cross lines will be at that point. Each of the above devices has been tried in this laboratory and found satisfactory, and others will probably suggest themselves.

It is true that such devices do not always succeed in making the center of the cross and the axis of the telescope coincide; but this is the case in but few cross wire spectroscopes, and, for that matter, a spectroscope is not a transit, and does not require such a rigid adjustment of the line of collimation as the latter instrument. If the center of the cross is at the center of the disc, and the disc fits its tube snugly, the cross lines will be sufficiently centered. Were an absolutely accurate adjustment of the line of collimation worth the cost, it could be secured by inserting an adjustable ring at the proper focal point and attaching the disc thereto.

The same method of supplying cross lines answers equally well for microscopical observations, either for goniometric, or for polariscopic work; in fact, it was from noting its utility in such microscopic work, that the idea arose of applying it to the spectroscopic investigations.

Several of the above-described discs have been made for this laboratory by the Bausch & Lomb Optical Co. and they have given perfect satisfaction.

C. M. CLARK

NOTE ON SOME PENNSYLVANIA FISHES

DURING the warm weather of 1908 and 1909 Mr. R. W. Wehrle, of Indiana, Indiana County, Pa., made a number of collections of fishes, amphibians and reptiles, from his vicinity. As almost all animal life is either extinct or rapidly becoming so in the main basin of the Conemaugh River, possibly the following list will be of use in partly recording a vanishing fish fauna. I take this opportunity to thank Mr. Wehrle for his care in collecting full series of specimens, besides notes and information relative to the former condition of the fish fauna. *Notropis photogenis* and *Micropterus dolomieu* are from Cherry Run and all the others are from Two Licks Creek, besides such other streams as may be mentioned after each. *Ichthyomyzon concolor, Salvelinus fontinalis, Campostoma anomalum,* also from Ramsey's Run; *Pimephales notatus,* Ramsey's Run, Harris's Run, Cherry Run and Marsh Run; *Semotilus atromaculatus,* Ramsey's, Harris's, Cherry and Marsh Runs; *Leuciscus elongatus,* Ramsey's and Harris's Runs; *Notropis cornutus,* Ramsey's and Cherry Runs; *N. atherinoides,* Cherry Run; *Ericymba buccata,* Cherry and Ram-

sey's Runs; *Rhinichthys atronasus*, Ramsey's and Marsh Runs; *Hybopsis kentuckiensis*, *Catostomus commersonnii*, Ramsey's and Cherry Runs; *C. nigricans*, *Moxostoma aureolum*, Cherry Run; *Ameiurus nebulosus*, *Noturus flavus*, *Ambloplites rupestris*, Ramsey's Run; *Hadropterus macrocephalus*, *Boleosoma nigrum*, Cherry and Marsh Runs; *Etheostoma flabellare*, Marsh Run; *Cottus gracilis*, Ramsey's Run.

On July 23, 1899, I secured an example of *Leuciscus margarita* in a tributary of the Alleghany River near Cole Grove, McKean County, the first I know of from that basin.

On July 1, 1907, Mr. T. D. Keim and myself took two examples of *Notropis boops* Gilbert from the Alleghany just above Foxburg, in Clarion County, also the first from that river.

I may note that *Coccogenia* Cockerell and Callaway, *Proc. Biol. Soc. Wash.*, XXII., 1909, p. 190, is an exact synonym of *Coccotis* Jordan, *Rep. Geol. Surv. Ohio*, IV., 1882, p. 852, type *Hypsilepis coccogenis* Cope, monotypic.

Henry W. Fowler
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SCIENTIFIC BOOKS

Die Geographische Verbreitung der Schmetterlinge. Dr. Arnold Pagenstecher. Mit zwei Karten. 8vo, pp. ix + 451. Verlag von Gustav Fischer in Jena. 1909.

Geheimrat Dr. Arnold Pagenstecher has long been favorably known to students of oriental lepidoptera as the author of a number of faunal and monographic papers of the highest merit. His investigations, which have chiefly related to the Malay Archipelago, inevitably led him to the consideration of questions of geographical distribution, and as the result of comprehensive studies we have before us the present volume.

The work divides itself into three sections. The first section, occupying fifty-nine pages, deals with the underlying causes of the geographical distribution of the lepidoptera. Soil, temperature, humidity, air-currents and vegetation are discussed with relation to the distribution of the forms of lepidopterous life. The distribution of the lepidoptera at various elevations above sea-level is considered. The migrations of butterflies, the cosmopolitan character of some species, seasonal dimorphism and local variation are touched upon. Several pages are devoted to the consideration of the influence of the glacial epoch and the various mutations which the surface of the earth has undergone in past geological ages. The influence of parasitic life upon the distribution of species concludes this portion of the work.

The second portion of the work, which occupies the body of the book, extending from page 62 to page 401, is devoted to a statement of the results which have thus far been reached by students of the lepidoptera who have written upon the faunæ of the various continents and islands. The various published lists of species are cited and briefly analyzed, and there is thus supplied a very valuable guide to the literature of the whole subject. This portion of the work displays enormous industry on the part of the author and a very thorough familiarity with what has been written. Dr. Pagenstecher recognizes eight faunal regions, and the distribution which he accepts may be given in tabular form as follows:

I. North-Polar Region.
   (The entire circumpolar northern arctic territory.)

II. Palæarctic (Europeo-Siberian) Region.
   Subregions.
   1. *European.*
   2. *Mediterranean.*
      Including the Azores, Madeira, the Canaries and Cape Verde Islands; northern Africa, Asia Minor and Syria, as well as all parts of Europe bordering on the northern shores of the Mediterranean.
   3. *Siberian.*
   4. *Manchurian.*
      Including Japan.

III. Indian Region.
   1. *India* to the Himalayan foot-hills.
   2. *Ceylonese.*
      Ceylon and the Maldives and Laccadives.

3. *Indo-Chinese.*
Southeastern Asia, including Hainan, Formosa and the Loochoo Islands.
4. *Malayan.*
Including Malacca and the islands north and west of a line drawn between Bali and Lombok, north and east between Borneo and the Philippines on the west and Celebes on the east (Wallace's Line).

IV. Australian Region.
Subregions.
1. *Austromalayan.*
All the islands east and south of Wallace's Line, including New Guinea, except as hereinafter mentioned.
2. *Australian.*
Australia and Tasmania.
3. *Polynesian.*
New Caledonia, the New Hebrides and the various archipelagoes northward and eastward as far as the Sandwich Islands.
4. *New Zealand.*
New Zealand and the Norfolk, Lord Howe, Auckland and Chatham Islands.

V. The Ethiopian Region.
(Africa south of the Mediterranean states, the Sudan, Madagascar and the nearer islands.)
Subregions.
1. *West African.*
Tropical West Africa, including St. Helena, Ascension and islands nearer the mainland.
2. *South African.*
(Temperate South Africa.)
3. *East African.*
Portuguese, German and British East Africa, the Sudan, Somaliland, Abyssinia, Aden and southern Arabia.
4. *Malagasy.*
Including Madagascar and the surrounding islands.

VI. North American (Nearctic) Region.
Including the entire continent north of Mexico and south of the Arctic or North Circumpolar Region.

VII. South American (Neotropical) Region.
Subregions.
1. *Chilean.*
Including Tierra del Fuego, Patagonia, Argentina, Chile, the Falkland, Juan Fernandez and Easter Islands.
2. *Brazilian.*
Covering all the continent north and east of the Chilean subregion, and including the Galapagos Islands and Trinidad.
3. *The Central American and Mexican.*
4. *West Indian.*
The Greater and Lesser Antilles.

VIII. Antarctic Region.
Kerguelen Islands.

A consideration of the foregoing arrangement shows that in a general way it accords with the known facts of distribution, but nevertheless is open to some objection, more particularly as it does not take account of the fact that many of the regions mapped out are invaded at various points by faunæ which persist at great elevations on the mountain-tops, or by faunæ extending through low-lying semi-tropical areas into more temperate regions. It is well known to students of the geographical distribution of the lepidoptera that the Sonoran fauna of the western portions of North America extends far south into the Central American subregion, and that even the Canadian fauna is represented upon the summits of the highest mountains not only of Central America, but of South America. The Chilean subregion is closely related in many respects to the North American fauna, and we have reason to believe that the genera which are found in the Argentine Republic and are also found in North America, owe their distribution throughout the entire length of the Cordilleran ranges and the temperate regions of South America and North America to a common center of original distribution. The southern extremity of Florida contains a lepidopterous fauna which is strictly West Indian. Similar phenomena present themselves to view in other parts of the world. It is no doubt difficult to adopt any general arrangement which will take account of these facts, and it may perhaps be asking too much to insist that in a work,

which like the present is intended to give a general view of the subject, these details should be emphasized. Upon the whole the arrangement of faunal regions accords well with what has been ascertained by the latest investigations.

The third portion of the book gives an account of the geographical distribution of the various families and genera of the lepidoptera in different parts of the world. Forty-six pages are devoted to this section. This part of the work is in the main satisfactory and as complete as could be expected within the limits of space assigned to the subject by the author.

It is of course impossible to expect that in a work of this magnitude errors should not creep in. Some of those which exist are, however, scarcely pardonable. On p. 4 we are informed that "In North America the entire center of the land between the Rocky Mountains and the Allegheny ranges is occupied by a desert extending southward over a large part of New Mexico, Texas, and northern Mexico." It is rather amazing at this late date to find the mythical "Great American Desert," which occupied a space upon the maps published at the beginning of the last century revived, and to have it even extended eastward as far as the Allegheny ranges through a now populous territory filled with large towns and cities, and abounding in agricultural resources. On page 6 the genus *Teracolus* is stated to occur in North America, as well as in the arid coast regions of northwestern and eastern Africa. This is a singular error. The genus is strictly confined to the old world, and not a single species occurs in the western hemisphere. In many places the work gives evidence of careless proof-reading, as on page 67, where "Irland" is substituted for "Island," thereby confusing the meaning; on page 315, where the word "Totenmeeres" is substituted for "Rotenmeeres," the Dead Sea being substituted for the Red Sea. Generic and specific names in a multitude of cases are misspelled. On page 317, near the foot of the page, where reference is made to a paper by the present reviewer upon the *Hesperiidæ* of Africa, eight generic names are cited, of which five are misspelled. Minor defects of this sort, while not detracting from the general value of the work, ought in a future edition to be rigidly excluded.

Upon the whole it may be said that this is the most comprehensive and satisfactory work upon the geographical distribution of the lepidoptera of the world which has up to the present time been written. While not free from defects, as has been suggested, it is a work which must prove itself of great value to all students of the lepidoptera, and it reflects great credit upon the learning and industry of its distinguished author.

W. J. Holland

QUOTATIONS

THE LENGTH OF SERVICE PENSIONS OF THE CARNEGIE FOUNDATION

The ethical question involved in the change, however, stands on quite a different basis. We do not find that anything in the report breaks the force of the criticisms made in the letters that have appeared in the *Evening Post,* one from Professor Lovejoy, of the University of Missouri, the other from Professor Weeks, of Columbia University. Nothing could be clearer or more unqualified than the statement in the original rule that professors of twenty-five years' service were "entitled" to the pensions. There is no telling in what degree the plans of professors and of colleges, for the past four years, have been based on the well-grounded expectation that this promise would be carried out. It is true that the foundation gave notice that its rules might be modified "in such manner as experience may indicate as desirable"; nobody can charge it with breach of contract. But to abolish completely, at a stroke, without notice, one of the cardinal features of the system is not the sort of thing that anybody had the slightest reason to anticipate.

Dr. Pritchett says that "the expectation that this rule would be taken advantage of almost wholly on the ground of disabilities has proved to be ill-founded"; but if this is meant as a defense against the charge of want of good faith, it betrays a misty notion of the nature of moral obligations. If disability was

meant to be the basis from the beginning, nothing would have been easier than to say so; if it was not, then it was absolutely honorable, right and proper for any man to avail himself of the retiring allowance offered him without reference to any question of disability. If an error was made in the first place, rectify it by all means; but first stand by the consequences of your error, to the extent demanded by the ordinary standards of honorable conduct between man and man. An absolutely essential requirement of a properly constituted university pension system is that it shall not place upon the professor any sense of obligation other than what is inevitable and inherent in such a system; he must feel that he has earned his pension, just as he has earned his salary, by his past services. If to retire under a pension is to mean to retire under a censorship, the Carnegie Foundation may conduce to the material comfort, but will certainly not conduce to the dignity or the self-respect of the profession of university teaching. And, to come back to the main point, the homely obligation of fulfilling in a reasonable measure substantial expectations that have been raised by one's own declared intentions is a duty antecedent even to the high purposes to which the Carnegie Foundation is dedicated.—New York *Evening Post.*

SPECIAL ARTICLES

DIPYLIDIUM CANINUM IN AN AMERICAN CHILD

IN May, 1909, Dr. Luzerne Coville, of Ithaca, submitted for examination egg packets and a segment of a parasitic worm which had been passed by a boy of eleven years. The segment, which had lain in water for some time, I did not recognize, and I am indebted to Dr. C. W. Stiles for the suggestion that the egg packets probably belonged to a tapeworm of the genus *Dipylidium.*

A short time later another segment, reddish-brown from the enclosed mature egg packets, was discharged and egg masses were found on toilet paper, appearing to casual inspection like blood stains. Careful examination proved them to be of the double-pored tapeworm of the dog, *Dipylidium caninum.* The standard vermifuges were administered and for two days the stools were sieved without result. It is evident that but a single worm was present and that it was discharged before the somewhat delayed treatment was commenced.

Dipylidium caninum (more generally known as *Tænia canina* L., *T. cucumerina* Bl. or *T. elliptica* Batsch) is the commonest tapeworm of pet dogs and cats. At Copenhagen, Krabbe found 78 per cent. of the dogs and 60 per cent. of the cats infested. Ward,[1] 1895, states that it has been found in one fifth to four fifths of all the dogs examined by various European investigators and that it is hardly less common at Lincoln, Nebr.; I have found it common at Ithaca, though I have not made enough examinations to justify a statement in percentages.

On the other hand, it is only accidentally a parasite of man, and instances of its occurrence as such have been regarded as rare. First reported in 1751, by Dubois,[2] a student of Linneus, Zschokke,[3] in 1903, was able to bring together reports of thirty-four cases. All these were European, and Ward,[4] 1900, found no references to the occurrence of the parasite in man in this country. However, Stiles,[5] 1903, reports a case of infestation of a child sixteen months old, at Detroit. Blanchard,[6] 1907, in an exhaustive review of the subject, summarizes sixty cases, of which

[1] Ward, H. B., "The Parasitic Worms of Man and the Domestic Animals," Rept. Nebr. State Board Agr. for 1894, pp. 225–348.

[2] Dubois, G., "Tænia." *Linnæi Amœnitates academicæ, Holmiæ,* 1751, II., p. 59. (Cited by Blanchard, *Traité de zool. méd.*, I., p. 481, 1888.)

[3] Zschokke, F., "Ein neuer Fall von *Dipylidium caninum* (L.) beim Menschen," *Centralbl. f. Bakt.*, etc., I. Abt., Originale, XXXIV., pp. 42–43, 1903.

[4] Ward, H. B., article "Cestoda," "Reference Handbook of the Medical Sciences," II., pp. 779–794, 1900.

[5] Stiles, C. W., "A Case of Infection with the Double-pored Dog Tapeworm (*Dipylidium caninum*) in an American Child," *Amer. Medicine,* V., pp. 65–66, 1903.

[6] Blanchard, R., "Parasitisme du *Dipylidium caninum* dans l'espèce humaine, à propos d'un cas nouveau," *Archiv. de Parasit.*, XI., pp. 439–471.

the only American is the case reported by Stiles. Since Blanchard's paper appeared, he has reported one new case at Paris, while one has been reported by Francaviglia for Italy, making a total of sixty-two reported cases. While, therefore, *Dipylidium caninum* can hardly be regarded as a rare parasite of man, Dr. Coville's case is worthy of record as occurring in this country.

From the view-point of the student of the relation of insects to disease, these cases are of interest because the intermediate hosts of this tapeworm are the dog louse, *Trichodectes canis*, and the flea, *Ctenocephalus canis*. Infestation can not take place directly from swallowing the eggs of the parasite, any more than in the case of other typical tapeworms, but only through ingestion of the infested insect. The dog normally becomes infested by biting the flea or louse. Man may accidentally ingest one of the insects and the parasites are able to complete their development in the unusual host.

This accounts for the fact that the great majority of cases reported are of young children, whose association with dogs and cats is more intimate, and who are likely to scrutinize less closely articles of food or drink. From Blanchard's summary, it appears that about 77 per cent. of the reported cases are of children under three years of age. Six are of adults and, counting Dr. Coville's case, three are of children between the ages of nine and twenty years. In the one under consideration, the boy's constant playmate was a bull terrier which was afterwards found to harbor the *Dipylidium*. WM. A. RILEY

ANTHROPOLOGY AT THE BOSTON MEETING, WITH PROCEEDINGS OF SECTION H

As was the case a year ago, the American Anthropological Association and the American Folk-Lore Society met in affiliation with Section H of the American Association for the Advancement of Science. The sessions which began on December 27 and lasted till noon on December 30 were held in the Engineering Building of the Massachusetts Institute of Technology. The attendance was better than a year ago and a number of important papers were presented. Professor William H. Holmes was present as vice-president of Section H and president of the American Anthropological Association, while Dr. John R. Swanton presided over the single session in charge of the American Folk-Lore Society.

SECTION H

Officers for the Boston meeting were nominated as follows: Member of the council, Professor Franz Boas; member of the general committee, Dr. Charles Peabody. Sectional offices were filled by the nomination of Professor Roland B. Dixon, Cambridge, Mass., as vice-president for the ensuing year; and Professor Geo. B. Gordon, member of the sectional committee to serve five years. In accordance with a change in the constitution enlarging the sectional committee, the section recommended to the council that the American Anthropological Association, the American Folk-Lore Society and the American Psychological Association be designated as societies suitable for affiliation with Section H.

Addresses and Papers

The address of Professor R. S. Woodworth, retiring vice-president of Section H, entitled "Racial Differences and Mental Traits," was published in SCIENCE on February 4. It was followed by an important discussion on related topics such as: brain weight in relation to race, intelligence and the finer structure of the brain; and the relative influences of heredity and environment, in which Professors H. H. Donaldson, Frederic Adams Woods, E. E. Southard, Franz Boas and J. McK. Cattell took part. The address of Dr. John R. Swanton, president of the American Folk-Lore Society, on "Some Practical Aspects of the Study of Myths," will be published in the *Folk-Lore Journal*.

Most of the papers read at the joint meeting are represented in this report by abstracts. These are:

Some Fundamental Characteristics of the Ute Language: Dr. EDWARD SAPIR.

The Ute language, originally spoken in much of Colorado and Utah, forms the easternmost dialect of the Ute-Chemehuevi subgroup, according to Kroeber's classification, of the plateau branch of the Shoshonean linguistic stock. It is itself spoken in at least two slightly different dialects, which may be termed Uintah and Uncompahgre Ute. The phonetics of Ute are only superficially easy, actually they are characterized by many subtleties. The consonantal system in its original form can, by internal evidence, be re-

duced to the "intermediate" stops p, t, velar q and labialized q^{w}, the sibilant c (really a sound intermediate between s and c), the nasals m, n and ñ and the voiced spirants w and y; in Uncompahgre ñ seems normally replaced by nasalization of preceding vowel. These consonants undergo various mechanical changes. Before vowels which, for one reason or another, have become voiceless, the stops become aspirated surds (p^{c}, t^{c}, q^{c} and q^{cw}), while the nasals w and y lose their voice, the voiceless *ñ* often, at least in Uncompahgre, becoming merely nasalized breath with the vocalic timbre of the reduced vowel. Between vowels the stops become voiced continuants (bilabial v, trilled tongue-tip r, velar spirant γ and γ^{w}). Lastly, if the stops are preceded by a vowel and followed by a voiceless vowel, they become voiceless continuants (voiceless bilabial *v*, voiceless r, x and x^{w}). Thus, an etymologically original intermediate p may appear in four phonetically distinct forms: p, p^{c}, v and *v;* the voiced stops (b, d, g, g^{w}) may also, though not normally, be heard as modifications of original intermediate stops, particularly after nasal consonants. To be carefully distinguished from the simple consonants are the long consonants (pp, tt, qq, qq^{w}, cc, mm and nn) and consonants with immediately following or simultaneous glottal affection (such as m•, w•, tt•). The vowels are perhaps more difficult to classify satisfactorily. As etymologically distinct vowels are probably to be considered a, u, i, weakly rounded ŏ, and perhaps ŭ and ĭ (Sweet's high-mixed-unrounded?). The influence of preceding and following vowels and consonants, however, gives these vowels various shades, so that actually a rather considerable number of distinct vowels are found (thus u may become close or open o, i before v is a very different vowel from i before γ, a is often palatilized to open e, and so on). The various vowels, in turn, exercise an important influence on neighboring consonants (thus i palatalizes preceding q to k^{y}, voiceless r has quite different timbres according to the quality of the reduced vowel following it, and so on). As often in English, it is possible to distinguish between slowly pronounced normal forms and allegro forms. Every syllable, in its original form, ends in a vowel or glottal catch; where it seems to end in a consonant, more careful analysis shows that the aspiration following it has a definite vocalic timbre. Words ending in a voiced vowel are invariably followed by a glottal catch or by a marked aspiration.

Nouns are, morphologically speaking, of two types. The absolute form is either identical with the stem, the final vowel of non-monosyllabic nouns becoming unvoiced (thus $p\tilde{a}^{c}$, "water," and pun q^{cu}, "pet horse," from stems pa and puñqu-), or certain suffixes may be added to the stem to make the absolute form. These suffixes are -ttc (from -ttci) and -n-tc, which are particularly common with nouns denoting animate beings, though often found also with other nouns, and $-v^{i}$ and $-m\text{-}p^{ci}$, which are often employed to give body-part nouns a generalized significance. In first members of compound nouns, which may be freely formed, these suffixes are lost, but with possessive pronouns -ttci is kept, while -vi and -mpi are lost. Only animate nouns regularly have plurals. Plurals are chiefly of three types: some nouns, particularly person nouns, have reduplicated plurals; others add *-w* (objective wa) to the stem; still others have a suffix $-m^{c}$. All nouns with possessive suffixes may form a reduplicated distributive meaning "each one's —." The possessive relation, when predicative, is generally expressed by the genitive-objective form of the independent person pronoun preceding the noun (thus $n\text{ĭ}^{a}$ nai $m\text{ŏ}^{ieco}$, "it is my hand," absolute mŏ• ŏ́ v^{i}), when attributive, by suffixed pronominal elements (thus $m\text{ŏ}^{\text{•}}$ŏ́-n^{c}, "my hand"). Eight pronominal suffixes are found: first singular, second singular, third singular animate, third singular or plural inanimate, first dual inclusive, first plural inclusive, first dual or plural exclusive and third plural animate. The genitive-objective or non-subjective form of the noun is made by suffixing -a, less commonly -i, to the stem, the possessive pronoun suffixes always following the objective element; as the objective -a often appears as a voiceless vowel, or, owing to sentence phonetics, may be elided altogether, the deceptive appearance is often brought about that the objective differs from the subjective merely in having the unreduced form of the stem (subj. pŭ́ñq^{ca} from pŭ́ñqu, obj. puñqŭ́^{ca} or puñqŭ́ from puñqŭ́a). A well-developed set of simple and compound postpositions or local suffixes define position and direction with considerable nicety.

Verb stems differ for singular and plural subjects, often also for singular and plural objects, the dual always following the singular stem. In some cases the singular and plural stems are unrelated, in others they are related, but differ in some more or less irregular respects, in still others the plural has a reduplicated form of the stem, and in many cases the plural is differentiated from the singular by the use of a suffix

-qqa (or -kk^y ä). Reduplication is used to express not only plurality of subject or object, but also repeated activity; some verb stems always appear in reduplicated form. The pronominal elements are the same as in the case of the possessive suffixes; they may either be appended to, not thoroughly incorporated with, the verb as suffixes, the objective elements always standing nearer the stem, or they may be appended as enclitics to a noun or adverb preceding the verb. When pronominal subject and object are both expressed as enclitics they may either appear together in either of the ways just described, or the subject may be attached to a word preceding the verb, while the object is suffixed to the verb; it seems that only third person pronominal enclitic objects can be combined with following enclitic subjects. Ute has both prefixes and suffixes in its verbs, the former being less transparently affixed elements. The most interesting of the prefixes are a set of elements defining body-part instrumentality; some of the ideas expressed by the suffixes are aoristic activity, futurity, intention, momentaneous action, completion and others. An important feature of Ute is the presence of numerous compound verbs, the second stem generally being a verb of going, standing, sitting or lying. Sometimes these second elements of compounds have quasiformal significance (thus "to be engaged in eating" is expressed by "to eat-sit").

On a Remarkable Birch-bark Fragment found in Iowa: Mr. Warren K. Moorehead.

Some thirteen years ago there were found near Fairfield, Iowa, two pieces of oak wood fitted together and covered with gum or wax. The oak had been cut with stone axes, and apparently the wax was of aboriginal origin. There was a slight hollow or cavity in the center of each piece of wood. When the wood was fitted together this cavity would be four inches square and an inch thick. Within this had been folded and placed a strip of birch bark of unknown length. The workmen in digging out this piece of wood struck it with a pick and broke it open. There was a strong wind blowing at the time, and half of the birch bark was blown away and lost. The other fragment was preserved and given to a school teacher. She sent the specimen to Mr. R. S. Peabody, founder of the museum at Andover. The author is convinced of the genuineness of this find. The specimens were submitted for examination and comment, the latter being favorable in respect to their authenticity.

The Condition of the Ojibway of Northern Minnesota: Mr. Warren K. Moorehead.

This paper, while not strictly ethnological in character, is based upon over four months' residence this summer with these Indians at White Earth, Minn., for the Indian Office, Washington. The Indians have abandoned their old-time customs and taken on many of the vices of the whites. The Mid-di-wi-win, or grand medicine society, was not as of old. Day Dodge, a man of eighty-two, is the sole survivor of the Mid-di-wi-win members of the old school, and to his keeping is entrusted the birch-bark records. He has agreed to translate these and present them to the museum at Andover.

These Indians have been cheated out of fully 90 per cent. of the 11,000 allotments of pine timber and farm lands issued to them by the government at Washington. They now live in unsanitary cabins, are crowded together and have lost much of their tribal life.

The Chronic Ill Health of Darwin: Dr. Robert Hessler.

A study of the chronic ill health of Darwin after the manner of the paleontologist, the data in the "Life and Letters" and "More Letters" being studied in the light of the ill health of a number of individuals who seem to have similar ill health. It is largely a study of environmental influences and of interpreting symptoms, not of disease, but of ill health, and showing on what the ill health depended. The paper was illustrated by charts.

Anthropology in the Peale Museum: Mr. Geo. H. Pepper.

The Peale Museum of Philadelphia was an institution of note in the days when scientific collecting was in its infancy. For many years it has been known that it contained a fair-sized collection of anthropological material, but none could say how much or what the character of the specimens.

Charles Willson Peale was the founder of this interesting institution which began its active career in 1794. The general history and a monograph on the ornithological specimens have been written, but no record of the anthropological material is known to exist. In the archives of the Pennsylvania Historical Society an accession book was found. It gives the accessions from 1805 to 1842 and it is from these entries that the major part of the information presented in this paper was obtained. The most interesting of

these were selected, and among them were the records of specimens obtained by Merriweather Lewis and William Clark, "In their voyage and journey of discovery up the Missouri to its source and to the Pacific Ocean." The rather long list of specimens noted are from the various tribes visited by these early explorers. Among other entries of note were specimens collected by Colonel Pike and other noted travelers.

A general history of the museum with its various homes and the final sale of the material brings the paper to the final disposition and fate of many of the specimens. All that are known to be in existence are now in the Peabody Museum of Harvard University at Cambridge, Mass.

Calf Mountain Mound in Manitoba: Professor HENRY MONTGOMERY.

In September last (1909) Professor Montgomery excavated an ancient artificial mound, which for many years has been known to the residents of southern Manitoba as "Calf Mountain." It is situated on a natural ridge in Manitou County. This mound is about eighty feet in diameter and ten feet in height. Openings had been made in it by other persons some twenty years ago. During the investigation of it about thirty days' work in digging has been expended upon this mound. The excavations brought to light nine burial places within a circular area of thirty-five feet in diameter, and under conditions which point to the mound's having been built in portions at different times. The objects in the burial places are in different conditions as to their preservation, and in addition to this the calcareous layers which covered the burials were found to overlap in such a manner that the more recent layers extended above and over the older ones without a break or interruption.

The objects found consisted of bone armlets with carving upon them, shell ornaments, copper beads, a piece of tanned hide, birch bark baskets, human skeletons and skulls of buffaloes.

Huron Moose Hair Embroidery: Dr. F. G. SPECK.

This paper deals objectively with the moose hair appliqués embroidery of the Huron Indians now living at Lorette, P. Q., Canada. The present known distribution of this type of decoration was given, followed by remarks on its antiquity and history. Details of the technique, of which there are six varieties, were treated and illustrated from specimens collected by the author and from those preserved in the collections of various museums. A list of nineteen decorative figures shows the prominence of flower designs in this art, since all but two of the figures represent either partial or complete flowers or trees. The author described and interpreted the figures found on various embroidered specimens. The paper concluded with a discussion of both the technique and the symbolism of Huron art, and, so far as was possible, a comparison of the designs with those of adjacent tribes. This paper, the material for which was obtained during several visits to Canada in 1908–9, is intended to appear, illustrated with figures and plates, in a new volume of the Anthropological Publications of the University of Pennsylvania Museum.

Assiniboine Folk-lore: Dr. ROBERT H. LOWIE.

The Assiniboine, as a Dakota tribe living for a long timé in close contact with the Cree, might naturally be expected to exhibit in their mythology traces of both Siouan and Algonkian influence. As a matter of fact, the trickster-hero cycle presents relatively few homologies with Siouan mythology, but bears the impress of western Algonkian influence. On the other hand, the miscellaneous folk-lore tales, while to a considerable extent shared by the same tribes, do not show the predominance of their influence, because an approximately equal number has also been recorded among the Omaha. From a psychological point of view, it is interesting to note that Inktonmi, who appears in the mythology of the Dakota proper as a pure trickster type, assumes among the Assiniboine some characteristics of the culture-hero. The secondary association of elsewhere distinct motives is also abundantly exemplified.

What is Totemism? Mr. A. A. GOLDENWEISER.

An analysis of the various definitions of totemism discloses a set of phenomena generally covered by that term. In examining the two typical totemic regions—Australia and northern British Columbia—we find them differing in all essential points. If we then follow up the various social and religious phenomena comprised in totemism, in a number of cultural areas we find that each one of these phenomena may and does occur independently, often stands for different psychological facts, and has an independent origin.

In totemism then we must see an association of these several factors. From this point of view totemism becomes the product of a process of convergent evolution, and we are confronted with a number of historical and psychological problems to be investigated.

The Myth of Seven Heads: Professor ALEXANDER F. CHAMBERLAIN.

Among the "miscellaneous tales" recorded by Dr. Clark Wissler and Mr. D. C. Duvall, in their recent monograph on the "Mythology of the Blackfoot Indians"[1] is "a myth of a seven-headed person who made a business of devouring young women." He is killed by a man who receives "power" from some animals for whom he settles a quarrel. The conclusion of the tale is as follows: "After this he married a princess. Then the thunder stole her, but he secured her by killing a lion, then an eagle, which flew out of the lion, then a rabbit, which came out of the eagle, then a dove, which came out of the rabbit, etc."

The authors cited comment upon this tale: "This story is believed by the Indians to have been brought in by the French." The conclusion certainly suggests such an origin, with its mention of a "princess," and the succession of animals killed.

But a "tale of Seven-heads" is known from the Kutenai,[2] the Arapaho and Sarcee—and probably also the Gros Ventre. So far as the present writer is aware, the only native text of the "tale of Seven-heads" hitherto obtained is the unpublished Kutenai version recorded in 1891 by him from the dictation of a Lower Kutenai Indian. In the Kutenai version Wistatlatlam (Seven-heads), is defeated and killed by a youth named Sanuktlaent (Bad Shirt), after he has been given "medicine," to make him strong, by a young woman, his wife. Here the tale is thoroughly Indian in aspect; the "princess" is absent; and the story ends by the hero cutting out or pulling out the tongue of his defeated adversary, and carrying it home as evidence of his triumph.

The Kutenai version seems to prove that we have here an original Indian legend, which in the case of the Blackfoot version noted above has been contaminated from European sources, the Kutenai retaining the simpler aboriginal form.

Professor W. H. Holmes, president of the joint meeting of Section H and the American Anthropological Association, read an important paper on "Some Problems of the American Race," which was illustrated by original and instructive diagrams. The paper, being still unfinished, will not be published at present. Dr. S. A. Barrett's two communications on "The Characteristics and Material Culture of the Cayapa-Indians" and "The Cayapa Spirit World" are extracts from a larger work which will appear shortly as part of a series printed privately and entitled, "Contributions to South American Archeology." The paper by Dr. George Grant MacCurdy, on "The Alligator Motive and Figures with Mixed Attributes in the Ancient Art of Chiriqui," is to appear as a monograph in the Anthropological Publications of the University of Pennsylvania.

Two other papers were read, of which the secretary has no abstracts: "Native American Ballads," by Mr. Phillips Barry; and "A Possible Explanation of Conventionalized Art," by Dr. H. J. Spinden.

The following papers were read by title:

(*a*) *Rock Inscriptions;* (*b*) *Stages of Progress in Parallels of Latitude:* Dr. STEPHEN D. PEET.

(*a*) *The Incensario;* (*b*) *The Distribution of Gray Pottery in the Pueblo Region:* Dr. WALTER HOUGH.

Symbolism in a Japanese Marriage: Mrs. SARAH S. JAMES.

Distribution of South American Linguistic Stocks (map): Professor A. F. CHAMBERLAIN.

An Introductory Paper on the Tewa Language (printed in this journal): Mr. JOHN P. HARRINGTON.

Literary Form in Oral Tradition: Professor FRANZ BOAS.

Folk Songs and Music of Cataluna: Mr. A. T. SINCLAIR.

A Grammatical Sketch of the Coos Language of Northwestern Oregon: Mr. LEO J. FRACHTENBERG.

One of the particularly attractive features of the week was "Cambridge Day," all members of the joint meeting being guests of the Division of Anthropology of Harvard University. The morning was spent at Peabody Museum, after which luncheon was served at the Colonial Club. Special cars were provided both to and from Cambridge. Many members also took advantage of the special facilities offered by their respective officers to visit the museums of anthropology at Salem and Andover. The social functions included a number of special luncheons and dinners given by local anthropologists and their friends.

GEORGE GRANT MACCURDY

YALE UNIVERSITY,
NEW HAVEN, CONN.

[1] *Anthrop. Pap. Amer. Mus. Nat. Hist.*, 1908, II., 163.

[2] Chamberlain, Rep. Brit. Assoc., 1892; Kroeber, *Anthrop. Pap. Amer. Mus. Nat. Hist.*, 1907, I., 57.

SOCIETIES AND ACADEMIES

THE INDIANA ACADEMY OF SCIENCE

AT the annual meeting of the Indiana Academy of Science, held at Indianapolis, Ind., on November 25–27, the twenty-fifth anniversary of the founding of the academy was celebrated. A special program was arranged under the direction of Honorable Amos W. Butler, one of the charter members of the academy and the acknowledged father of it. His plan was to bring together not only the present membership, but all the living ex-presidents and charter members as well as representatives of the educational and scientific societies of this and adjoining states. Among those who responded to this invitation were President Jordan, of Leland Stanford University; J. M. Coulter, of Chicago University; H. W. Wiley, chief of the Bureau of Chemistry, and B. W. Evermann, of the Bureau of Fisheries, Washington, D. C.; W. A. Noyes, of the University of Illinois; C. A. Waldo, of Washington University, St. Louis; Dr. A. Springer, of Cincinnati, and George T. Moore, of the St. Louis Botanical Gardens. In addition delegates were present representing the Indiana Teachers' Association, the Indiana Medical Society, the Indiana Section of the American Chemical Society, the Indiana Audubon Society, the Indiana Engineers' Society, the Indiana Historical Society, the Indiana Physics Teachers' Society, the Association of Science and Mathematics Teachers.

At the general sessions on Friday about three hundred were present to listen to the addresses of A. L. Foley, president of the academy, President Jordan and Professor J. M. Coulter. The same evening a banquet was held in the Claypool Hotel at which covers were laid for more than one hundred. Professor D. W. Dennis, of Earlham College, acted as toastmaster and responses were made by President Jordan, Dr. A. Springer, Hon. B. W. Everman, Professors J. M. Coulter, Glenn Culbertson, Geo. T. Moore and M. H. Stuart. The membership committee reported fifty-six names for membership. The following were elected officers for the coming year:

President—P. N. Evans, Purdue University.

Vice-president—C. R. Dryer, State Normal School.

Secretary—G. W. Benton, Shortridge High School, Indianapolis.

Assistant Secretary—A. J. Bigney, Moore's Hill College.

Treasurer—W. J. Moenkhaus, State University.

Editor—H. L. Bruner, Butler College.

The papers and addresses will appear in the *Proceedings*, which is published annually from an appropriation made by the state. The following is the program of the meeting:

Thursday, November 25

Meeting of the executive committee.

Informal dinner.

Address—"By Packtrain to the Tiptop of the United States in Quest of the Golden Trout," B. W. Evermann, U. S. Bureau of Fisheries, Washington, D. C.

Friday, November 26

President's Address—"Recent Progress in Physics," Dr. A. L. Foley, Bloomington.

Address—"Recent Progress in Chemistry," Dr. H. W. Wiley, chief of the Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

Address—"Recent Progress in Botany," Dr. John M. Coulter, department of botany, Chicago University.

Greetings from other societies.

Informal luncheon.

Address—"Darwin Fifty Years after," Dr. David Starr Jordan, president Leland Stanford University, president of the American Association for the Advancement of Science.

The academy met in sections. A few papers, mostly those of historical character, were read.

Banquet—D. W. Dennis, toastmaster.

Saturday, November 27

Address—"Methods and Materials used in Soil Testing," H. A. Huston, Chicago.

Address—"Federal Control of International and Interstate Waters," B. W. Evermann, U. S. Bureau of Fisheries.

Address—"The Speed of Migration of Salmon in the Columbia River," Charles W. Greene, University of Missouri.

Address—"Some Hoosier and Academy Experiences," C. A. Waldo, Washington University, St. Louis, Mo.

Suggestions. Plans for the Academy—John S. Wright, Stanley Coulter, H. E. Barnard, W. E. Stone, C. Leo Mees, W. A. Cogshall.

The following is a complete list of papers presented:

General

"Thought Stimulation, under what Conditions does it Occur?" Robert Hessler.

"Does Blood Tell?" William B. Streeter, Greensboro, N. C.

"Hygiene of Indoor Swimming Pools, with Sug-

gestions for Practical Disinfection," Severance Burrage.

"Indiana Problems in Sewage Disposal," R. L. Sackett.

"Defective Elementary Science," William N. Heiney.

"Some Hoosier and Academy Experiences," C. A. Waldo, Washington University.

"Darwin Fifty Years After," David Starr Jordan, president Leland Stanford Jr. University.

"Streamers that Show Reversal of Curvature in the Corona of 1893," John A. Miller.

"That Erroneous Hiawatha," Albert B. Reagan.

Chemistry

"Methods and Materials used in Soil Testing," H. A. Huston, Chicago, Ill.

"The Discovery of the Composition of Water" (illustrated), W. A. Noyes, University of Illinois.

"Molecular Rearrangements of Derivatives of Camphor," W. A. Noyes.

"Use of Refractometer in Dry Substance Estimation," A. Hugh Bryan, U. S. Bureau of Chemistry.

"Conductivity and Ionization of Solutions of Certain Salts in Ethyl Amine," E. G. Mahin.

"Recent Progress in Chemistry," H. W. Wiley, chief of the Bureau of Chemistry, U. S. Department of Agriculture.

"Electric Osmose," Harry N. Holmes.

"On a New Complex Copper Cyanogen Compound," A. R. Middleton.

"Determination of Endothermic Gases by Combustion," A. R. Middleton.

Mathematics

"A Method of Instruction in Solid Analytical Geometry," Arthur S. Hathaway.

"The Relative and Reduced Equations of Motion of n Bodies in Space of n Dimensions or Less," Arthur S. Hathaway.

"Discussion of the Regular Inscribed Pentagon," John C. Gregg.

"If the Bisectors of Two Angles of a Triangle are Equal, those Angles are Equal," John C. Gregg.

Physics

"Direct Reading Accelerometers," C. R. Moore.

"Recent Work in Wood Physics," W. K. Hatt.

"Expansion of Paving Blocks," W. K. Hatt.

"Strength of Building Block," H. H. Schofield.

"Slip of Riveted Joints," Albert Smith.

"Polarization of a Cadmium Cell," Rolla R. Ramsey.

"Investigation of the Point Discharge in a Magnetic Field," Oscar W. Silvey.

"The Tenacity of Gelatine," Arthur L. Foley.

"Objections to LaPlace's Theory of Capillarity," Arthur L. Foley.

"Cohesion of Water as Modified by Certain Dissolved Salts," Edwin Morrison.

Geology and Geography

"Some Features of Delta Formation," Charles R. Dryer.

"A Physiographic Survey of an Area near Terre Haute, Ind.," Charles R. Dryer, Melvin K. Davis.

"The Collecting Area of the Waters of the Hot Springs of Hot Springs, Ark.," A. H. Purdue, University of Arkansas.

"The Geographical and Geological Distribution of Some Pleistocene Mammals," O. P. Hay, U. S. National Museum.

"On the Restoration of Skeletons of Fossil Vertebrates," O. P. Hay.

"Paleontology and the Recapitulation Theory," E. R. Cummings.

"The Tippecanoe, an Infantile Drainage System," W. A. McBeth.

"Observations on Cyclones and Anti-cyclones of North Temperate Latitudes," W. A. McBeth.

Zoology

"A Paired Entoplastron in Trionyx and its Significance," Henry H. Lane, Oklahoma State University.

"Physiological Explanation of the Psycho-physical Law of Weber," Guido Bell.

"On the Nature and Source of Thrombin," L. J. Rettger.

"Federal Control of International and Interstate Waters," B. W. Evermann, U. S. Bureau of Fisheries.

"By Packtrain to the Tiptop of the United States in Quest of the Golden Trout" (illustrated), B. W. Evermann.

"The History of Zoology in Indiana," C. H. Eigenmann.

"An Analytic Study of the Faunal Changes in Indiana," Walter L. Hahn, South Dakota State Normal School.

"Some Notes on Parasites found in Frogs in the Vicinity of St. Paul in June," H. L. Osborn, Hamline University.

"The Mocking Bird in Indiana," A. J. Bigney.

"Cross-fertilization among Fishes," W. J. Moenkhaus.

"Observations on Woodpeckers," John T. Campbell.

"The Development of the Reproductive Organs of *Chara fragilis*," George N. Hoffer.

"Paroxysmal Hemoglobinuria," Oliver P. Terry.

"The Evolution of Insect Galls as Illustrated by the Genus Amphibolips," Mel T. Cook, Delaware College.

"The Speed of Migration of Salmon in the Columbia River," Charles W. Greene, University of Missouri.

"Observations on Cerebral Localization," J. Rollin Slonaker, Leland Stanford Jr. University.

"A Study of the Composition of Butter Fat," O. F. Hunziker, G. W. Spitzer.

"The Nasal Muscles of Vertebrates," H. L. Bruner.

Botany

"Physiological Apparatus," Frank M. Andrews.

"Some Monstrosities in Plants," Frank M. Andrews.

"A List of Algæ," Frank M. Andrews.

"Revegetation of the Salton Basin" (illustrated), D. T. MacDougal, director Desert Laboratory, Tucson, Ariz.

"Forest Conditions in Indiana," Stanley Coulter.

"Some Additions to Indiana Flora, Number 4," Charles C. Deam.

"The Medicinal Value of *Eupatorium perfoliatum*," A. J. Bigney.

"Right and Wrong Conceptions of Plant Rusts," J. C. Arthur.

"The Effect of Preservatives on the Development of Penicillium," Katherine Golden Bitting.

"Recent Progress in Botany," John M. Coulter, Chicago University.

J. H. RANSOM,
Secretary

THE KANSAS ACADEMY OF SCIENCE

THE academy held its forty-second annual meeting at Ottawa, Kans., on December 28, 29 and 30.

After the usual business meeting on the evening of December 28, Professor Frank E. Jones, of the University of Kansas, lectured on "A Tour of the Philippines." The lecture was very interesting and illustrated by projections of many photographs, obtained by the author during several years' residence in the islands.

On Wednesday the reading and discussion of papers were taken up from the following program:

"A Suggested Revision of the Terminology of Agriculture," by L. C. Wooster.

"An Esker near Mason, Mich.," by L. C. Wooster.

"A Rare Mexican Cycad," by W. B. Wilson.

"Recent Methods in Organic Analysis," by E. R. Groner.

"Successful Termination of the Loco Weed Investigation," by L. E. Sayre.

"Analysis of Food Accessories under the Food and Drugs Law," by L. E. Sayre.

"Physical Culture in Schools," by J. H. Klopfer.

"The Dance and Shamanic Performances of the Quileute Indians," by A. B. Reagan.

"Sketches of Indian Life and Character," by A. B. Reagan.

"Maxwell's Method of Comparing Electrostatic Capacity with Self-inductance," by J. A. G. Shirk.

"A New Geometrical Figure and its Possible Application," by E. C. Warfel.

"Preliminary Note on Measuring the Speed of Photographic Shutters," by H. I. Woods.

"Pollution of Domestic Ground Water Supply," by S. J. Crumbine.

"Tools and Toys," by B. B. Smyth.

"Milk-sickness in Kansas," by L. C. R. Smith.

"The Flora of Minima Hill," by L. C. R. Smyth.

"An Embryonic Plesiosaur Propodial," by R. L. Moodie.

"Provisional List of the Flora of Kansas," by B. B. Smyth, John H. Schaffner and L. C. R. Smyth.

"Is the Dakota Formation Upper or Lower Cretaceous?" by J. E. Todd.

"Further Notes on Pleistocene Drainage," by J. E. Todd.

"An Aberrant Walnut?" by I. D. Cardiff.

"Fifty Years of Evolution," by A. H. Thompson.

"Additions to the List of Kansas Coleoptera for 1909," by W. Knaus.

"Note on the Food of *Bothrotes Knausii* Caley," by W. Knaus.

"Notes on Kansas Coleoptera," by W. Knaus.

"Kansas Coleoptera—the Families Throscidæ, Lampyridæ, Malachidæ, Clevidæ, Cupescidæ, Cioidæ, Melandoyidæ, Oedemeridæ, Anthicidæ, Pyrochroidæ and Rhipiphoridæ," by W. Knaus.

"Changes in the Cottonwood Limestone South of Cottonwood Falls," by J. A. Yates.

"On the Coloring Matter in Fruits," by E. H. S. Bailey and E. L. Tague.

"On the Occurrence of Manganese in Waters," by C. C. Young.

"A Comparison of Some Methods of Making Thymine," by D. F. McFarland.

"On Food Adulterations," by H. L. Jackson.

"The Prairie Dog Situation in Kansas," by T. H. Scheffer.

"Investigating the Mole," by T. H. Scheffer.

"Catalytic Tests and Treatment of Systematic Phtysis," by W. P. McCartney.

"Midcontinent Petroleum," by F. W. Bushong.

"Some Difficulties in Arsenic Tests," by F. B. Dains.

"In the Laramie and Niobrara Cretaceous," by C. H. Sternberg.

"Observations on Cytology of *Equisetum*," by I. D. Cardiff.

The time was closely occupied in this order till 6 P.M., when the academy repaired to Charlton Cottage to partake of an elegant banquet tendered by the local members.

Following the banquet the retiring president, Dr. F. B. Dains, gave an address on "The Lives of Silliman, Hare and Cook, and their Influence on American Science." Dr. J. T. Lovewell gave some personal reminiscences of the elder Silliman and of the methods of teaching chemistry fifty years ago.

On Thursday the reading and discussion of papers were resumed, and in the free and instructive comments and questions, much interest was manifested and advantages gained.

The academy is growing in numbers and influence, having now about two hundred members, and is enlarging its library and museum. In the near future it will have rooms in the Memorial Building, now being erected in Topeka, the state capital, and have a permanence of quarters it has hitherto lacked. The annual volumes of *Transactions*, now published by the academy, are growing in size and value and are welcomed as exchanges by most scientific societies. The present officers were reelected for the ensuing year:

President—F. B. Dains, Topeka.

Vice-presidents—J. M. McWharf, Ottawa, and A. J. Smith, Emporia.

Treasurer—F. W. Bushong, Lawrence.

Secretary—J. T. Lovewell, Topeka.

Topeka will be the place of next meeting and the time will probably be during the Christmas holidays.

J. T. Lovewell

THE CHICAGO ACADEMY OF SCIENCES

At the annual meeting of the Chicago Academy of Sciences, held January 11, the following officers were elected:

President—Dr. T. C. Chamberlin.

First Vice-president—Mr. A. L. Stevenson.

Second Vice-president—Mr. C. H. Blatchford.

Secretary—Dr. Wallace W. Atwood.

Head Curator—Mr. Frank C. Baker.

The honorary curators were elected as follows: Dr. Thomas C. Chamberlin, general geology; Dr. Stuart Weller, paleontology; Dr. Oliver C. Farrington, mineralogy; Professor E. J. Hill, botany.

Annual reports were received from the trustees, the secretary, the treasurer and the curator. During the past year the emphasis in the museum work has been placed upon ecological exhibits and on the preparation of loan collections suitable for use in the public and private schools of the city. The demand for such material has greatly exceeded the supply and the work will be conducted on a larger scale during the coming year. The academy has undertaken during the past year to enter more intimately and actively into cooperation with the educational institutions of the city to improve and extend the teaching of nature study to the children and the science courses in high schools. To this end a course of instruction was offered to the teachers by Dr. Henry C. Cowles, of the University of Chicago, on "Plants and their Field Relations." For the children, a series of Saturday afternoon lessons was arranged. These were given by Dr. Herman S. Pepoon. The children were admitted as delegates from the seventh and eighth grades in the public schools, each delegate representing his, or her, class. Over one hundred applicants applied for this course and the reports from the teachers and the principals indicate that each delegate returned to the class with an enthusiastic report of the work which had been offered at the academy. These new lines of work were supplemented by lectures given at the schools by members of the staff and by evening lectures at the academy building which were open to the public and to which school delegates were also admitted. The cooperation on the part of the teachers and the principals has been most gratifying and the trustees of the academy have appropriated funds for the continuation and development of the educational and museum extension work during the coming year.

During the past year the academy published a bulletin, on the "Higher Fungi of the Chicago Region," by Dr. Will S. Moffatt. This bulletin is illustrated with twenty-three full-page half-tone plates.

Mr. Frank C. Baker has completed for publication a monograph on the "Lymnæidæ of Middle and North America." This work is the result of ten years of study involving the examination of all the large collections of mollusks in the United States.

Other research work is in progress and additional publications will probably appear during the coming year.

The relationship of the academy to the public during the past year may be tabulated as follows:

Annual attendance to museum	300,000
Annual attendance to public lectures	4,000
Attendance at the 12 lessons in the first teachers' course (28 teachers × 12 lessons)	336
Attendance at the 6 lessons in the young people's course (6 lessons × 122 pupils)	732
School children addressed by delegates to young people's course	50,000
Children addressed at schools by Mr. F. C. Baker, of museum staff	11,303
Loan collections from museum (129 school rooms averaging 50 pupils)	6,450
Total	372,821

WALLACE W. ATWOOD,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 365th meeting of the society was held January 22, in the main hall of George Washington University, with President T. S. Palmer in the chair and about a hundred persons present.

The following communication was presented:

Fluctuation of Animal Population in the Northwest: ERNEST THOMPSON SETON.

The speaker described conditions as to animal life observed during his long residence in Manitoba, instancing the marked changes in numbers of indigenous mammals to be seen from year to year. Shrews, muskrats, rabbits, lynxes, wolves and other animals were subject to great fluctuation in numbers. In some cases the causes of change were partially known, but in others they could not be explained. Mr. Seton exhibited charts showing diagrammatically the yearly collections of skins of fur-bearing animals by the Hudson's Bay Company. These showed in a clear way the enormous fluctuations in the fur returns during the years from 1751 to 1891.

An interesting discussion followed. D. E. Lantz called attention to the fact that the prevailing fashions in fur garments often have much to do with the numbers of skins collected. Dr. Palmer showed how the prevailing fashion influences the sale of bird skins and feathers, and how it has often disastrously affected the bird population of certain districts and nearly exterminated a species.

Vernon Bailey told of the occasional vast increases in numbers of small mammals, referring especially to the field mice (*Microtus montana*), which in 1907 and 1908 did enormous injury to crops in the Carson and other valleys of the west. In this instance predatory mammals and birds assisted by unfavorable weather conditions were recognized factors in removing the plague of mice.

Dr. A. D. Hopkins told of the enormous fluctuations in numbers of certain insects, well-known illustrations being afforded by plagues of locusts and crickets and the periodical appearance of cicadas. He gave as a particular illustration the northward migration of the southern pine bark beetle (*Dendroctonus frontalis*), which in 1891 and 1892 culminated in the destruction of a large part of the pine and spruce timber on about 75,000 square miles of the forests of Pennsylvania, Maryland, Virginia and West Virginia. Being a southern species, it could not withstand the extreme cold of the winter of 1892–3, and the species perished throughout the region named, while native insects were not killed. In this case, the sudden change in numbers was well understood.

Dr. Barton W. Evermann called attention to the fact that there is a well-marked periodicity in the run of certain species of fishes. This is notably the case with the humpback salmon in the rivers of the Puget Sound region and the sockeye salmon in the Fraser River. A large run of humpbacks takes place in the odd years (as in 1905, 1907, etc.) and a much smaller run in the even years. A big run of sockeyes occurs every fourth year, the run in each of the three other years of the cycle being smaller. The reasons for this periodicity are not fully understood. These species of salmon, like all salmon on our west coast, spawn only once, then die, even before the eggs hatch; so that no Pacific salmon ever saw any of its children or either of its parents. The life of the sockeye salmon is probably four years. The eggs laid in the Fraser River produce fish which come back four years later to spawn. If the spawning conditions in some year of the remote past were exceptionally favorable and an unusual number of young fish hatched, every fourth year thereafter ought to be a big year for that species. It is believed that an explanation like this is the correct one.

The discussion was closed by Dr. Palmer and Mr. Seton, and the society then adjourned.

D. E. LANTZ,
Recording Secretary

THE BOTANICAL SOCIETY OF WASHINGTON

THE fifty-ninth regular meeting of the society was held at the Ebbitt House, January 29, 1910, at eight o'clock, P.M.; President Wm. A. Taylor presided. The following papers were read:

Legal Regulation of Plant Diseases: Dr. HAVEN METCALF, U. S. Bureau of Plant Industry.

Further Botanical Evidence regarding Coastal Subsidence: H. H. BARTLETT, U. S. Bureau of Plant Industry.

The full paper will appear in a forthcoming number of *Rhodora*.

The Use of the Immersion Refractometer in the Study of Plant Extracts: H. C. GORE, U. S. Bureau of Chemistry.

The Zeiss immersion refractometer, an instrument which measures index of refraction of liquids in terms of an arbitrary scale, was shown and its probable usefulness in vegetable physiological studies was illustrated by readings on cane sugar and on cider. The arbitrary scale is so constructed that in many cases the readings, less the amounts due to the presence of water, are almost exactly proportional to the amounts of dissolved substance. This is particularly true for dilute solutions, *e. g.*, dilute solutions of sugars. Tables can therefore easily be constructed for any substances or groups of substances for which tables are now lacking. Solutions can be examined rapidly. Small amounts are required, 1 c.c. being sufficient, though more is desirable, and the solution need not be clear. Further, a definite physical constant, the index of refraction, is determined.

The instrument is brought to the attention of botanists because it is well adapted to field work, and has been found to be very useful in detecting slight differences in sugar content, therefore it may be used in making selections among sugar-containing plants and fruits, and in detecting differences in soluble carbohydrates due to slight changes in environment. The refractometer has been found very useful in the study of the rate of fermentation of apple cider in cold storage. It is also widely used in technical work and in food analysis.

A preliminary study of the ratio of the scale readings, less 15, the reading due to pure water at 17.5° C., to the per cent. of cane sugar in solution, shows that the ratio varies from 3.75 to 4.09 for amounts of sugar from 2.5 to 16 per cent., the figures being as follows:

Per Cent. of Cane Sugar	Ratio of Scale Readings less 15, to Per Cent. of Sugar.
2.5	3.75
5.0	3.81
9.0	3.91
13.0	4.01
17.0	4.09

A study of the ratio of the scale readings less 15, to the total solids, of 13 samples of freshly pressed cider showed the ratio to be 3.91, with a maximum of 4.09 and a minimum of 3.79. It is practicable, therefore, to work out for a plant juice a factor which will relate the scale readings to the content of total solids. By making a proper allowance, to be determined experimentally, for the readings due to the non-sugar solids, the sugars can probably be estimated with a fair degree of accuracy.

W. W. STOCKBERGER,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT the 441st regular meeting, held February 1, 1910, Dr. D. S. Lamb read a paper entitled, "Like Father Like Son: A Study in Heredity."

After a general introduction the speaker gave especial consideration to variations and illustrated with many cases taken from Darwin, Reid, Thomson, Woods, Fay and others. As to reversions, he was inclined to think that many so-called reversions are simply arrests of development. He thought that the attitude of writers on heredity now in regard to the inheritance of acquired characters is that of a negative. As to the inheritance of disease, there was no doubt that a tendency to disease was frequently inherited. The probabilities are that the sperm or ovum is affected by the disease of the parent. He disbelieved in telegony and maternal impressions. A brief statement was made of the more important theories of heredity; he inclined to the Mendelian principle as set forth by Bateson.

In the discussion Mrs. G. R. Stetson and Dr. G. M. Kober pointed out the importance of the problem of heredity in its relation to practical life, especially to education, marriage, public health, and the treatment of criminals and defectives.

Dr. J. Walter Fewkes exhibited and commented on some drawings of divinities, altars and other paraphernalia of worship made by Hopi Indians under his supervision.

I. M. CASANOWICZ,
Secretary

SCIENCE

FRIDAY, MARCH 11, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE FUNCTIONS OF A UNIVERSITY LABORATORY[1]

ON an occasion like the present, when we are gathered to congratulate this university upon the addition which it has just made to the existing equipment of the world for the prosecution of scientific studies, it seems appropriate, and it may not be entirely superfluous, to spend a little time in inquiry what it is that scientific laboratories have done for mankind during their comparatively brief past; to ask also how we may make them still more serviceable in the years which are to come.

It is not so very many years ago that a speaker upon this subject might have deemed it necessary to prove to his hearers (if he could) that laboratories were of service to the public and that they ought to be established and maintained. I am very glad that this is no longer necessary; that I may assume with confidence your acquiescence in the belief that scientific studies have been justified by their results. And I am very glad also that these results, great as they are, have, as yet, nothing like finality about them. To say that the natural sciences are still very imperfect and capable of vast improvements is only another way of saying that they are alive. Those of us who are devoted to their service have especial reason for joy in the fact that there is still so much to be done that we see no prospect of this service becoming unnecessary in our time or in that of our successors for many generations.

When one speaks of the beneficial results

[1] Address on the occasion of the opening of the Carnegie Science Building at Acadia University, Wolfville, N. S., October 21, 1909.

of scientific studies, it is only natural that the first things which arise in the mind should be the concrete things—the great practical benefits which have become so much a part of our lives that we wonder how our ancestors could have been comfortable without them. We think of all that the engineers have done for us with steam and electricity; and we remember that all the modern industrial applications of electricity had their origin in Faraday's laboratory; that wireless telegraphy, which has added to the security of all those who go down to the sea in ships, was born in the laboratory of Hertz. In our admiration of the great achievements of genius we do not forget the humbler services of lesser men who have attended to the details; who have made improvements here and there; and who, in the aggregate, have contributed incalculably to the results which we see all about us. But laboratories have done more than to provide opportunities for discoveries great and small, which are afterward put to the practical service of mankind. In them has been trained the great army of experts who keep the machinery of our industrial civilization running, and upon whose skill and knowledge we depend every day more than we know for safety, prosperity and comfort. This educational function of laboratories is of the greatest importance from whatever point of view we regard the subject, and we shall have occasion again to consider it more in detail.

It is not only in the domain of engineering (which is mainly applied physics) that we see these great, tangible results. Chemistry and biology are in no way behind their sister science in the direct benefits which they have conferred upon us. We have only to think of the enormous improvements which the study of chemistry has made possible in manufactures, in metallurgy and in many other branches of industry, to recognize what chemistry has done for the world. And in addition to such services, chemistry has powerfully assisted biology in the magnificent contributions which have been made to the cause of human health and security within the past two or three decades. Even a partial enumeration of these advances is convincing. Antiseptic surgery, the germ theory of infectious diseases, antitoxins, methods of stamping out such plagues as malaria and yellow-fever, the lessening of infant mortality—can any one compute how much sorrow and suffering have been prevented by these discoveries? And without laboratories and without men trained in laboratories, we should have had none of them.

All these things are obvious enough; even the "man in the street" is not in much doubt about them. But is there anything beyond this, anything less tangible and therefore more difficult to state and to perceive, anything higher and nobler than these concrete practical services? We should not, I think, find such entire unanimity in answer to this question as we encounter with regard to the so-called practical results of the sciences. Many people who have not thought much about the matter and some people who have thought much, but whose work and sympathies lie in other directions, would still be inclined to define science as "useful knowledge" with a very narrow signification of the word useful. To such persons, the sciences find their sole excuse for existence in their practical applications; if they look with amused tolerance upon the enthusiasm of spectacled professors over a discovery in pure science, it is only because they have come to realize that, in the course of time, even the most unpromising discovery may have important practical applications. Of course we have no monopoly of such unsatisfactory supporters; the

philistine is a thorn in the flesh of artists and moralists—especially the patronizing philistine. But I am inclined to think that men of science have more than their just share of that sort of thing; that, in other words, the number of people who can appreciate (if only dimly) the idea of art for art's sake is far greater than the number of those who can understand why science should be cultivated irrespective of its possible applications.

On the other hand, the professed followers of pure science regard the "useful" consequences of their work as a mere by-product—and one which must not be allowed to usurp the chief place in their hopes and plans. In fact, they are sometimes accused (and with some show of justice) of leaning too far in the other direction and despising everything that is practical. This undoubtedly is a wrong attitude and a very short-sighted one; no one who takes an unprejudiced view of the matter can doubt that, apart from their general beneficial effects, the applications of science have a most favorable reaction upon the progress of purely scientific studies. Not only does the prospect of useful technical results bring to scientific studies much greater support and financial aid than they would otherwise enjoy, but the progress of technology always assists in many ways the science with which it is most closely connected—by the development of instruments and appliances upon a commercial scale, by the purely scientific problems which are suggested in the course of the development of the applications, and by the stimulus which comes from the activity of large numbers of earnest men in closely related lines of work. Many things are easy to us to-day which would have caused Faraday infinite trouble and labor, just because the electrical engineers have been busy in producing such cheap and convenient instruments and appliances.

I can not leave this phase of the subject, however, without attempting to offer an excuse for the somewhat intolerant attitude which the student of pure science sometimes assumes toward his brother who deals only with its useful applications. Almost every successful man of science is constantly tempted to engage in technical work of some kind. Invitations come to him which mean an opportunity to do work which is obviously useful to the world. He knows that the material rewards for such work are usually much greater than for purely scientific achievements and he usually needs money as much as other people. He knows too that in all probability he will gain much more general commendation and applause along with the money; for the contemporary fame of even a very distinguished scholar is limited to a surprisingly small circle of people. At a recent academic celebration the degree of doctor of laws was conferred upon a number of prominent and well-known men; honorary degrees in letters and in science were also conferred, and a wise and observant spectator said afterward that the recipients of these latter degrees must have been distinguished scholars, for he had never heard of any of them before.

Well, our man of science knows these things and he is sorely tempted; but he also knows that if he yields he must give up the better part of his scientific work; he knows that there are ten men willing to take up the popular and profitable task for every one who is content to devote his time and energy to the other. So he resists the temptation; and if it helps him and comforts him to regard the part which he has chosen as the better part, as a little more honorable and dignified and worthy than the one which he has refused, we can hardly wish to deny him that consolation.

But is he right in his action? Is the ideal for which he is giving up money and possible fame one which is worthy of the sacrifice? Is there anything in science beyond its more obvious utilities? To put the question in another way, has this new laboratory and others like it throughout the world any other legitimate function than the training of technical experts and the making of discoveries which may be useful in a direct material way? I hope you will agree with me that it does have other functions to perform and that they are higher and more important than those we have been discussing.

As before, these activities are manifested chiefly in two directions—in the education of youth and in the discovery of new truth; in teaching and in research. Only in this case, we mean by teaching not simply the training of an expert for a particular task, the fashioning of a cog to be slipped into its proper place in the industrial machine, but the fostering and bringing a little nearer to perfection of a human mind and of all its powers, intellectual, esthetic, moral.

Can the study of the sciences do these things for us or any of them, and can we perhaps conclude that they are especially well adapted to perform certain parts of this task of general development of mind and character?

I must admit at once that, to the great majority of students, the esthetic aspect of science makes a very small appeal. In fact it is supposed by many people to be entirely lacking. Every one who has seriously studied one of the physical or natural sciences, however, knows that it is there, and that it is indeed one of the greatest incentives and rewards for such study. A great scientific theory with its component parts accurately adjusted to each other in due proportion and subordination, with great complexity of detail blended into the grandeur of perfect simplicity; such a structure makes upon the mind which is fitted to enjoy it an impression of beauty which is quite comparable with that which is produced by a French cathedral, a play of Shakespeare or a symphony of Beethoven. But it must be admitted that the ability to enjoy this kind of art is rarer and perhaps requires a longer apprenticeship than the appreciation of literature or music or painting. We must, of course, take into account that it is the fashion to pretend to like music and pictures even if one does not really enjoy them, while, on the other hand, there is, fortunately, no temptation to feign a liking for scientific pursuits. But when all such allowances are made, I think there can be little doubt that the number of people who find esthetic stimulus in music, for example, is much greater, and that the number who find it in literature is enormously greater, than the number who can see the beauty of science.

When we turn to the consideration of the more purely intellectual faculties we shall not, I believe, find the sciences at a disadvantage in comparison with other subjects used for the disciplinary training of young men and women. In the opinion of many people they possess indeed a certain superiority which especially fits them to serve some of the most important ends of education. Is there any justification for such an opinion? I think we must recognize, in the first place, that the experimental sciences possess a certain advantage in the relatively great simplicity of their subject matter. They are complicated enough—even physics, the simplest of all is quite sufficiently intricate—to give one all the work he wants in disentangling their puzzles. But the puzzles *are* disentangled and one definite and certain result

after another is arrived at. The problems we have to deal with are simple in comparison with those with which the historian, for example, has to struggle, at least if he attempts anything like the degree of completeness in his solution which we habitually attain. And just because we have attempted a relatively modest task, it has been done with a finish and degree of completeness which makes it particularly suitable to serve as a model of right thinking and as a means of training the minds of young people in the methods of attacking greater difficulties. Easy exercises in careful observation, right inductions, logical deductions, in which the result is definite and known, and a straying step can be detected at any point of the path—these do not make a bad beginning in the process of training the young mind to use its intellectual faculties to the best advantage. I have called this process easy, and yet, as we all know, students do not regard it as altogether a path of roses; in fact they are usually of the opinion that economics or sociology is easier than (for example) physics. Now I am quite ready to admit that a process of close, accurate, careful thinking is never *very* easy; but if a man is to be well educated he must have training in such processes, and I am contending that it is possible in the experimental sciences, on account of their relative simplicity, to lead men along such paths and to guide and check their progress with a degree of precision that is too difficult even to be attempted in subjects of study which deal with more complex bodies of facts. They therefore seldom attempt it, and the student finds them easy; but he has missed a very vital part of education if he has not been through this particular mill.

I have been regarding scientific studies from the disciplinary point of view, as valuable to the individual student, especially if his after life is to be devoted to something else than science, because they supply him with a standard of careful and exact thinking to which he may approximate as closely as he can in the more complicated affairs of life. I think we may find some justification for this view of the place of scientific studies in the education of the individual, by a little consideration of the position which such studies have occupied in the history of the general development of thought since they have become conspicuous factors in that development. Nobody can doubt that their direct influence has been very great; and it is not at all certain that their indirect effect upon the attitude and methods of scholars in other fields of study has not been nearly or quite as great. We all know that philologians, historians, moralists, even some literary critics, have a very different point of view and very different methods of work from their predecessors of three hundred years ago. They think more of facts and less of words; they are more cautious in reaching conclusions and in defining the probability of the correctness of their results; they are more careful to guard against being prejudiced by external circumstances and implications; they get as near to first-hand evidence as they can. A great many of them are proud of using a "scientific" method and most of them habitually give the name of science to their subjects of study.

Now I am far from assuming that the so-called scientific method is, in its details, an entirely new invention; it is, after all, only applied common-sense and men have been using it in practical affairs since before the dawn of history. But its use as a definite, conscious, consistent policy, the recognition of its value and of its limitations, the perfection of its application, these, I believe, we do owe mainly to the

initiative of the students of the experimental sciences; and that the rest of the world of scholars owes much to their example. Here again I must make a qualification lest I should be misunderstood. I do not wish to imply that the essential priority which is thus claimed for the experimental sciences is due to any superior wisdom on the part of its students; on the contrary, I believe that it was the comparative simplicity of the task they had before them which enabled them to teach the world how more difficult problems are to be solved when their time comes. And I wish to draw your attention to the parallel between this general process and the place which I have been claiming for scientific studies in the education of the individual student. If we are right in believing that the study of the experimental sciences is mainly responsible for this particular step forward in the intellectual development of mankind, then we must conclude that this is a greater, a higher, a more vital service than the invention of trolley-cars, the production of cheap dye-stuffs, or even the suppression of yellow fever. And if scientific studies are peculiarly adapted to the purpose of leading young men into the paths of careful, sensible, fearless, original thinking then these new laboratories of yours have a much higher educational function to perform than merely to produce engineers or technical chemists or practising physicians.

And now we come to a still more vital question; how about the young man's morals? Have scientific studies any ethical effect, and if so is it in the right direction or the wrong one? The problem is a specific one and so we may leave to one side the ancient question as to how much knowledge has to do with conduct. It may be that perfect knowledge of good and evil would inevitably result in the choice of the good and that the will would, under such ideal conditions, be the servant of the intellect. But we know, alas! that perfect knowledge of good and evil is no more the attribute of any human mind than perfect knowledge of scientific truth; and we see too many instances in which a man knows and approves the better path and yet follows the worse, to be able to believe that morality is a matter of knowledge alone. It is plain, however, that sound knowledge and intellectual judgment must in general be antecedent to the deliberate choice of virtue; and that some training of the will itself is possible; if it be led to choose the good and the true habitually in lesser things, it is more likely to react nobly in times of stress and difficulty. These are doubtless minor functions in the domain of morals, but they are very necessary ones; and I think it may be successfully maintained that the natural sciences are strong allies of the forces which are fighting on the side of virtue in the great battle of good and evil.

Let the truth be proclaimed though the heavens fall, has been and must continue to be the fundamental principle of real science. At times in the past it has seemed to many that the heavens were falling—but they have not fallen; on the contrary, they have acquired a new glory which our eyes had not before seen. The medieval church thought quite honestly that Galileo, if he were allowed to go on, might wreck the universe at least for those who believed him. But how different has been the real result of his labors and of the work of those astronomers who have followed after him. For us it is true, with a depth and intensity which David could not have known, that "the heavens declare the glory of God; and the firmament sheweth his handiwork."

So in the middle of the nineteenth cen-

tury there were many who believed that, if the theories of Darwin were allowed to prevail, we should see religion and morality involved in one common ruin. But we all know now that this has not happened; that, on the contrary, the doctrine of evolution has furnished us with new and valuable criteria for judging conduct; that it has given us additional reasons for hating sin and a rational basis for charity toward the sinner. And as a comment on the fears of those who in those times of storm and stress thought that science was the enemy of religion I may quote the concluding sentence of the address of the president of the British Association for the Advancement of Science, at the meeting in Winnipeg last summer, just fifty years after the publication of Darwin's great work:

> As we conquer peak after peak we see in front of us regions full of interest and beauty but we do not see our goal, we do not see the horizon; in the distance tower still higher peaks which will yield to those who ascend them still wider prospects, and deepen the feeling, the truth of which is emphasized by every advance in science, that "great are the works of the Lord."

We may, I am sure, dismiss from our minds the last lingering fear that the pursuit of science tends toward irreligion or immorality. We may go still further and with confidence deny the more common belief that physical science is unmoral, that it has no concern with ethical questions. On the contrary, its whole attitude and most fundamental enthusiasms are thoroughly permeated by the great ethical principles. No one who studies science aright can fail to recognize this fact; and no one who has taught the principles of any science to young men, and who has watched their after development, can doubt the strong, if indirect, effect which such studies have had upon them in the direction of clearer moral judgments and more unselfish devotion to duty.

I come now to the last of the important functions of a university laboratory which I wish to discuss before you to-day. It is scarcely necessary to say that this is research—not simply the attempt to add to man's material comfort by new appliances, not the seeking of useful knowledge in any narrow sense, but the diligent and devoted search after new truth for its own sake, careless of consequences so long as the truth is served. This is a great and lofty ideal and it is followed with all the enthusiasm and loyalty which a high ideal inspires, and which nothing else in the world can inspire. Now I should not for a moment wish to persuade you that the scientific investigator is actuated only by unselfish motives; he is not quite such a monster of virtue as that. Dr. Jowett once said that we were all liable to error—even the youngest of us; and it may be admitted freely also that we are all human—even the most scientific of us. But I am convinced from considerable observation of men of science that by far the strongest selfish motive which actuates them, especially those in the higher ranks of ability, is the great pleasure which they take in the work itself. That this pleasure is so keen and satisfying is a consequence of the ideal character of the work; it is the sort of pleasure which the artist finds in his real pictures—and does not find in his pot-boilers. It is true also that scientific men are very glad when they can obtain the commendation and respect of their professional brethren; but what soldier, what statesman, what minister of the gospel does not share in the desire for such intelligent approbation. It is a confirmation of his hopes that his strenuous labors are not in vain; and it adds a human element to his reward, the desire for which, if it is a weakness, is certainly an amiable one. The true man of science, the true scholar in

any department of knowledge, does not desire unintelligent popular applause; and it is almost always safe to conclude that the "newspaper scientist," the man whose name and deeds are constantly before the public, is not having a very great or beneficial effect upon the progress of his science.

True research, real scientific pioneering, does not strongly appeal to the general public; its applications may be remote, it shows no immediate profit, its achievements are not spectacular and are often too technical to be fully understood by any but experts. And thus it comes about that it must be fostered, encouraged and supported by the more enlightened fraction of mankind; and the chief agency through which this support may be given is the university or college. I will go further than this and express the decided opinion that no other institution has been devised or seems likely to be invented which can perform the task so well. Of late years there have been established a number of institutions of various types, especially for research; they have done excellent work and it has seemed to many that such foundations might probably absorb gradually the research functions of the universities. The ground for this expectation is that, as they have nothing else to do except to advance knowledge, whereas the universities must also teach young men, the institutions for research alone must inevitably surpass the universities in achievement and eventually take over the whole business of research. We must remember, however, in the first place, that research is not altogether a business, but an art as well; and that while organization and division of labor may be the life of business, it is not the soul of art. To produce the highest results in scientific research there must be individuality and freedom, and there is room for far more individuality in a university laboratory than in any special research laboratory which has hitherto been established or seems likely to be established.

There is a certain sort of new knowledge which can be gained more readily by the well-organized, machine-like attack of government departments and special institutions than by the guerilla warfare of the universities. There are great bodies of facts, relations, properties of matter, and habits of living beings which have only to be looked for to be found; as soon as we have time, money, a corps of trained men, and especially proper organization, we may count upon a steady annual crop of new knowledge of this kind. Institutions of the type we have been discussing are doing admirable service to science by pushing forward such work. It seems, *a priori*, almost inevitable that their work should be mainly in this direction; it is the work for which their organization is best fitted—and it is a sure thing. When an institution exists solely for research, when a man gets his salary for research alone, then the results must appear pretty regularly and promptly, or there is likely to be trouble. The institution, or the man, knows that he must reckon with human nature—especially with the human nature of administrative officers; and in consequence we find (as we should expect) that, in nine cases out of ten, the productions under such conditions are very steady, very voluminous, very meritorious and very dull. Now the collection of facts of this kind is most necessary, but it is *only* "the beginning of wisdom" in science; such collections are not science but only the raw material out of which science may possibly be made if the right men arise for the task. It is here that the university laboratory, that the college professor, has

his opportunity—an opportunity which has been made use of brilliantly in the past and which I hope and believe will not be neglected in the future. For the university professor is not compelled to stick to the sure thing in research; it is not necessary that he should make an annual or semi-annual contribution to science, for he has another excuse for living and drawing his salary. And so it comes about that he is much freer to attack bigger problems, the outcome of which is very uncertain and which may after several years of work lead to no conclusive result. Such work, if intelligently undertaken and carried out, is by no means a waste of time; great results are always accompanied by great risks; and no great discovery has ever been made by a man who was unwilling or unable to risk a great failure.

Even if we return to lower ground, to the "business" analogy which was used a moment ago, I believe that university laboratories are not at a hopeless disadvantage as compared with special institutions for research. For the most successful manufactory is not always the one which adheres most closely to one specialty but the one which most successfully utilizes its bye-products. Now I am a very strong believer in Lord Kelvin's opinion that in a university, so far as is humanly possible, every investigator should be a teacher and every teacher an investigator. The reaction of the two forms of activity on each other is immensely stimulating and helpful. To the man whose chief concern is the investigation of special problems on the remote borders of knowledge, it is very wholesome that he should occasionally survey his subject broadly and in simple terms, as he must do if he teaches young men. On the other hand, he conveys to them some part of his own enthusiasm and, in some cases, makes recruits for scientific investigation; and when he does this he multiplies his own effectiveness many times in the present and future activities of his pupils.

In the same way the man who, from natural bent, or from force of circumstances, finds his chief usefulness as a teacher, is greatly helped in the proper fulfillment of that most important service, if he can spend some part of his time in research. The teacher who does nothing else, who goes over the same subject year after year with successive classes, is of all men, I think, the most in danger of intellectual stagnation. While he is young he may ward off this paralysis by study, by the acquisition of knowledge which other men have discovered. But (with somewhat rare exceptions) the real passion for such acquisition and the pleasure one takes in it are nearly gone by the time middle age is reached. In fact a great deal of the capacity for such study has also vanished by that time. We all know how much easier it is to acquire a new language when one is young, and how much less patient we are of the drill and drudgery of grammar as the years go on. I do not believe I shall ever learn Russian or Swedish; certainly I should expect no pleasure in the early stages of the study. And I am quite sure that, if I had not learned the multiplication table when I was a boy, I should never learn it now and should be obliged to carry it about on a card in my pocket.

Now so far as I have been able to observe, the passion for research and the pleasure which it gives do not pall as the years go on. As we read the biographies of men of science we find that the fascination of the game is as strong or stronger to the veteran of seventy-five as to the youth of twenty-five. Unless ill-health or some other circumstance prevents, they usually keep steadily and enthusiastically at their

task until the end of life; and in many cases even serious decrepitude can not stop them.

So I believe that engaging in research is the best way and the only certain way for a teacher to keep himself alive intellectually and to retain his spirit and enthusiasm to the end. And even if the college he serves regards teaching and not research as its chief business, even then, I contend, he must be given a reasonable amount of time and reasonable opportunities for research in order that he may keep his intellectual health, just as he is given time for physical exercise in order that he may maintain his bodily health.

Fortunately too, the process is not an esoteric mystery open only to the elect, but a thing which can be taught and learned by ordinary men. It is true that great discoveries are not made by ordinary men—at least not often. But there is a great deal of useful work quite within the powers of almost any intelligent man which will add to the knowledge of the world and add to the happiness and usefulness of the man himself and to his success as a teacher. He must usually be taught the elements of the process and started on his career as an investigator in order to be able to accomplish much; and he must have some time and energy left over from his teaching to devote to this purpose. Both these conditions are being fulfilled more and more as time goes on; and the result will be, I believe, that the profession of the teacher will attract more able men, that they will keep their vigor and enthusiasm longer, and that the quality of their teaching will be much improved.

By the establishment and equipment of this building, Acadia is lending a helping hand toward the fulfillment of that promise, whose complete fulfillment we shall never see on this earth but toward which we are constantly making progress: "Ye shall know the truth and the truth shall make you free."

H. A. Bumstead

Yale University

THE CARNEGIE FOUNDATION AND ITS SERVICE PENSIONS

The announcement of the Carnegie Foundation that it is the intention to limit retiring allowances on the basis of a twenty-five years' service to cases of disability, has brought dismay and surprise both to those directly interested and to the larger public to whom academic interests are of concern. The report of the foundation stating this action and its reasons is now available; and the propriety as well as the wisdom of the change in rules may be discussed.[1]

There are three issues involved: whether the reasons given for the abandonment of one of the two fundamental provisions of the foundation are adequate, legitimate and convincing; whether independently of its desirability the abandonment of the original plan is made necessary by financial reasons; whether the sudden withdrawal from the obligations which the foundation has assumed is just.

The practical importance of the last issue entitles it to first place in the immediate situation; and on this matter it is possible

[1] Since the situation requires a certain freedom of expression, I may be permitted to explain that I have publicly and privately expressed the most cordial approval of the foundation, its purposes and its provisions, particularly and above all of the provision which is now to be withdrawn. Articles in the *Dial* will sufficiently indicate this fact. An article in the *North American Review* will further indicate the high opinion I formed of the influence of the foundation and of the necessity of including the state universities in order that this influence shall be of national scope. This commendation must stand as evidence of my interest and favorable attitude towards the foundation and its mission.

to let others speak. Professor Lovejoy[2] draws attention to the ethical obligations involved toward those men who very naturally were looking forward in the immediate future to a retirement under the provision so unexpectedly withdrawn. It must be evident that the expectations thus aroused carry with them every essential factor of an implied contract. The withdrawal of this right affects at once a group of men who were looking forward to taking advantage of its arrangements within the next five or ten years, and affects them in a manner so particularly unfortunate that they need not hesitate to refer to this personal aspect of the situation. But the yet more serious side of this sudden withdrawal is that it reflects so unfavorably upon the foundation itself. One of the prominent arguments used by the foundation in establishing its provisions was that the professor could look far ahead and with *absolute security* to the benefit thus to be conferred. An institution that radically changes the essential scope of its purpose within four years is not suggestive of security. It will be extremely difficult, even if the present problem is reconsidered and more satisfactorily solved, to assure professors that other provisions will not be withdrawn and with no more convincing reasons. Nor can any refuge be taken in the fact that the foundation reserved to itself the power to change its rules. Every reasonable understanding of that proviso would interpret it to refer to minor changes in administration, not to a radical and far-reaching abandonment of a distinct and explicit provision. On this point the *Evening Post*, of February 28, leaves nothing to be said, unless it be to indicate that Professor Lovejoy does not stand alone in his fear that "a body which at a moment's notice abandons one of the two purposes constituting its proclaimed *raison d'être* is equally likely to modify the other to any assignable degree." The editorial concludes thus:

[2] *Nation*, February 3.

Dr. Pritchett says that "the expectation that this rule would be taken advantage of almost wholly on the ground of disabilities has proved to be ill-founded"; but if this is meant as a defence against the charge of want of good faith, it betrays a misty notion of the nature of moral obligations. If disability was meant to be the basis from the beginning, nothing would have been easier than to say so; if it was not, then it was absolutely honorable, right and proper for any man to avail himself of the retiring allowance offered him without reference to any question of disability. If an error was made in the first place, rectify it by all means; but first stand by the consequences of your error, to the extent demanded by the ordinary standards of honorable conduct between man and man. An absolutely essential requirement of a properly constituted university pension system is that it shall not place upon the professor any sense of obligation other than what is inevitable and inherent in such a system; he must feel that he has earned his pension, just as he has earned his salary, by his past services. If to retire under a pension is to mean to retire under a censorship, the Carnegie Foundation may conduce to the material comfort, but will certainly not conduce to the dignity or the self-respect of the profession of university teaching. And, to come back to the main point, the homely obligation of fulfilling in a reasonable measure substantial expectations that have been raised by one's own declared intentions is a duty antecedent even to the high purposes to which the Carnegie Foundation is dedicated.

The immediate object of endeavor may well be to bring to the attention of the trustees, in as convincing a manner as possible, the categorical imperative of the obligation which they have assumed. There is much to be said for the view that this obligation extends to all institutions that have already become accredited to the foundation. But moral obligations are not incompatible with a reasonable regard for the practical situation. If the foundation could be prevailed upon to adopt in place of the measure now upon its records, an

announcement that unless the financial and other conditions are decidedly altered, the foundation will find it advisable to withdraw (except in cases of disability and such other cases as may be specified) the right of an allowance on the service basis, after the year 1915 or 1920, it may be confidently expected that the academic world will accept this announcement with deep regret, but without that feeling of righteous indignation or moral resentment which is so forcibly expressed by the writer of the editorial just cited. The first and paramount obligation is for the foundation to clear its record and restore confidence in the value of its mission, in the directness of its methods, and the unquestioned acceptance of its obligations. A ten-year period is none too long for such an announcement; for it may well be that with the situation clearly foreseen, measures may be taken to continue the service retirement upon some modified basis which will tend to the advancement of the profession, and to the retention of the influence of the foundation.

To proceed to the consideration of the situation as it stands: The report shows that as yet only one fourth of the funds for retirement allowances is expended for service grants, while three fourths of the funds go for age grants. It appears that this is regarded as a large ratio; but that depends upon how one views the desirability and the value of service allowances. One who believes strongly in the value of such allowances will hold that to them might properly (in an experience of twenty to thirty years) be assigned the larger rather than the smaller share of the funds. But the argument advanced by the report expresses dissatisfaction with the working of this retirement provision for the following reasons, and concludes that the service pension for professors is a mistake: First, that universities are likely to bring undue pressure to bear to retire professors who are willing and should be permitted to continue their service. Second, that there will arise a "tendency of the teacher assured of a retiring allowance to become ultra-critical toward the administration." Third, that the hope that such allowances would prove an aid to research is one which on the whole seems illusive. Fourth, that too many men accept the allowance because they are tired of teaching, or wish to go into business, or to engage in some activity irrelevant to the purpose of the foundation. "It seems that this rule offers too large a temptation to certain qualities of universal human nature"—but yet, if universal, why were they not considered three or four years ago? Fifth, that of forty men retired on this basis, only twelve retired for disability. This is regarded as a disproportion, although there is nothing in the original provision which suggests that the main purpose of the rule was to provide for cases of disability. Sixth, while there is no explicit statement that this is a cause for the action, the conclusion may be inferred that a continuance of this policy would overtax the available funds.

To the first it might be replied that if the universities so offend, the foundation should withdraw the right of retirement by the universities until they can show good cause for their actions; to the second, that the sin of being critical towards the administration is a form of *lêse majesté* not likely to be seriously regarded in a professedly democratic community, at all events not so seriously as to cancel a right (?) to a pension; to the third, that it all depends upon what manner of men occupy professorial chairs, and that the purpose of the foundation is to so improve conditions that the right type of men may more readily be induced to enter this career; to the fourth, that the needlessly severe conditions of the

academic life are more responsible for this situation than the "human nature" of the professors; to the fifth, that it is rather complimentary to the physique of the teaching profession that more have not qualified for the privilege of disability—or are those who succumbed the unhonored martyrs who are not even a burden to the Carnegie Foundation?; to the sixth, that foresight in not promising what can not be fulfilled is demanded of every business-like institution.

But it is obvious that in reality too many questions are involved in this issue to make it possible, or in the present connection desirable, to consider them in detail. It is sufficient to call attention to the fact that every system, however worthy or wise, is open to abuse; but the abuse must be very considerable and extended before it justifies so drastic a cure. It must be remembered that in every transition from one system to another, there necessarily follows a period of adjustment, and that the value of the provision can be decided not by its abuses but by its uses, and that only after the academic career in this country has become adjusted to the Carnegie provisions. It would seem to be much fairer to wait twenty years and see what men actually do who withdraw under this provision, before deciding that it is a mistake. In brief, the question as to how far this provision of the foundation is a mistake can not at this stage be decided by the experience obtained, but must be appraised according to the value attached to this method of advancing the attractiveness of the academic career. This is so wholly a matter of opinion that there is little to be gained by opposing one opinion to another; but it should be pointed out that at least one member of the board of trustees of the foundation, President Jordan, has taken a very opposite view, and tells the public that "the retirement of men in good health to pursue their studies unhampered may be regarded as one of the most important functions of the Carnegie Foundation." If what is regarded on the one hand as a mistake is regarded on the other as a most important function, this conflict of view is sufficient to make one pause before justifying so radical a step by so questionable a consideration.

But at this point it becomes quite impossible to avoid the reflection that the actual considerations are really the financial ones, and that the reasons given would of themselves (without the financial difficulty) have seemed quite inadequate to many who participated in the decision. This reflection is again a very serious one. If the provision had to be abandoned for financial considerations, that fact should have been stated prominently, frankly and without complication with other reasons.[3] All universities are so troubled by a lack of funds that such a statement would at once seem natural and in an academic community would command full sympathy. And so again if this provision is not a mistake, but merely another instance in which a high and far-reaching ideal has to be given up for a more limited range of service, that is likewise a very familiar academic situation with which every one

[3] In regard to the financial side, it may be recalled that in Mr. Carnegie's original letter giving ten million dollars for the foundation, it was said that "expert calculation shows that the revenue will be ample for the purpose." If this calculation, however expert, has proved to be a mistake, it is that mistake which most needs acknowledgment. At the same time it should be understood that the load of the service allowance is not wholly an additional burden upon the foundation, since with the ordinary expectation of life some of those who retire on the less favorable basis but near to the age of sixty-five will draw no more from the foundation than if they retired upon the more favorable basis a few years later.

sympathizes. If the provision is a mistake, no one can be expected to make an effort to prevent its withdrawal or to secure larger financial support to make possible its continuance; but if the provision is a most desirable and important function of the foundation, it should be possible to enlist the interest that has already so generously provided these funds to further support the foundation and render it as comprehensively efficient as was originally intended. Here as everywhere in academic administration, it is most essential that the right reasons be stated for the action taken, so that academic interests and financial questions may not be confused.

President Jordan distinctly states that it is the financial difficulty that is largely responsible for the withdrawal of the provision. If this is the case, the responsibility of anticipating this condition four years ago can hardly be avoided; and it becomes difficult to explain how so recently as two years ago an actual extension of the liberality of the retiring provisions was made. Originally the maximum grant was limited to $3,000, but in 1907 this was advanced to $4,000. Now it appears that this change affects on the age basis only those whose salaries range from $5,300 to $7,200, and on the twenty-five-year basis only those whose salaries range from $6,800 to $9,200. It is certainly an unpleasant reflection that almost all those who might be affected by this increased allowance are university presidents, many of them perhaps members of the board that made this decision. Surely if funds were likely to be inadequate, this was hardly the point at which an increased generosity was permissible.

It should be added that there is another factor in the situation, which appears in the instructions to the executive committee, which is directed

to safeguard the interests of the following classes of cases: (*a*) those who have research work in view and have shown themselves unmistakably fit to pursue it; (*b*) those whose twenty-five years of service include service as a college president; and, (*c*) those in whose mind a definite expectation has been created by official action that they will be accorded the benefits of the foundation within the year 1910.

These instructions appear in President Jordan's letter; and it is at least a slight consolation to be informed through his letter that there is no intention to enforce the rule retroactively for the present year. The change in the rules consequent upon these instructions indicates that in spite of the withdrawal of the service allowance the trustees are willing to grant an allowance "to the rare professor whose proved ability to research promises a fruitful contribution to the advancement of knowledge, if he were able to devote his entire time to study or research; and the trustees may also grant [a similar allowance] to the executive head of an institution who has displayed distinguished ability as a teacher and educational administrator." This censorship by the foundation of the merits of applicants clearly destroys the initial policy of the foundation which gave to the professor the right of a pension. The pension as a favor, with an emphasis upon that aspect of the academic career least germane to the purposes of the foundation, is a totally different matter from the far-reaching and beneficent policy which brought to the foundation its most cordial supporters. It is peculiarly difficult to understand why a policy which for the professor has proved to be a mistake shall yet be reserved as a privilege for the president; while again, it seems peculiarly invidious to insert the adjective "rare" before the "professor" and omit it in case of the "president."

While I can not agree that the service allowance can within so short an experience

be proved to be a mistake, I believe that there is one factor in the constitution of the foundation that this brief experience proves to be a mistake. I refer to the absence from its board of trustees of a number of men who can and will safeguard, as well as express and understand, the interests of the professors. Presidents can, if they will, do this in part; but they can not fully represent the academic and the administrative interests (both fully justified) at once. Is it not a fair presumption that if half of the members of the board had been university professors, the precipitate withdrawal of the service provision—not to say the indefensible repudiation of obligations presently to mature—would have been avoided?

And so I ask whether it would not be well for the foundation to collect opinions upon the desirability of service allowances and have them brought before the trustees. If it shall prove that a considerable number agree with President Jordan, it is to be hoped that measures will be taken to secure for the foundation the exercise of this important service. I may repeat in this connection a proposal that was suggested years ago, that the universities themselves be required to provide part of the funds for retiring allowances; that at the outset they should have been asked to consent to a contingent provision that if at any time the service allowance proves to be too heavy a tax upon the foundation, the universities shall carry the load until the men reach the age of sixty-five; or equally it might have been urged that it is a greater privilege for the foundation to provide the allowance after twenty-five years' service and let the universities carry the age provision. I may also be permitted to say that from the outset it seemed to me that quite the wisest provision to really advance the academic profession was to have made possible a system of half retirement, upon which men after twenty-five years of service shall be relieved of most of their teaching, while yet they give to the university the influence of their presence, their reputation and their ripe scholarship.

Not alone has the foundation without notice withdrawn a portion of its program of most vital concern to the academic profession, but the official channel of its expression announces that the change thus decided upon "will command the approval of the great body of devoted and able teachers and is in accordance with the spirit of the rules as originally framed." For my part, I have no choice but to incur the odium of exclusion from this approval and content myself with showing what modest devotion or ability I may possess in other directions, in order to retain my right of protest that the change itself (whether enforced or not) is most regrettable, and that there is nothing in the spirit of the original rules that foreshadows the interpretation that has now been made. It is pertinent to recall that a point of great emphasis in the original provisions is that the right to a retiring allowance shall come to the professor undisputed and as a result of his own initiative. It was this feature that brought the largest commendation to the foundation and that was instrumental in inducing institutions that already had a pension system to give it up in favor of the Carnegie provisions. There were many who four years ago predicted that in spite of this provision the fund would be administered as a semi-charitable old-age pension fund. To this objection it was then possible to reply that the twenty-five years retirement allowance distinctly gave to the professor some control of the use of the allowance in a dignified manner and to serve the cause of education. If this provision is abandoned, it is not quite obvious how one

is to reply to the view that incapacity and old age are suggestive of charity and not of the advancement of the teaching profession. As one who is interested in the causes which the foundation was instituted to promote, I can not look with equanimity upon the curtailment of the influence of the foundation as now proposed, and I am willing to risk the confusion of personal interest with a disinterested view of the benefit to the teaching profession in order that the question may be seen as a whole and not decided abruptly by mere temporary expediency.

Two obligations seem to rest upon the foundation in order to reinstate its influence and to justify its mission. In an unequivocal and equally in a generous manner it must meet the obligations which its announcements have aroused in the minds of those who within a few years will be in a position to take advantage of its formulated provisions; and in the second place, to reinstate confidence in its methods, there should be a plain statement to the effect that the financial difficulty is or is not the determining cause of the present action. If such prove to be the case, let the arguments against a system be held in reserve, and let the actual situation be met in that same helpful spirit which has characterized so many of its important and beneficial decisions.

JOSEPH JASTROW

COLUMBIA UNIVERSITY,
March 2, 1910

AN AMERICAN RESEARCH INSTITUTION IN PALESTINE. THE JEWISH AGRICULTURAL EXPERIMENT STATION AT HAIFA

A NEW American institute of research has just been incorporated in New York under the title of the "Jewish Agricultural Experiment Station," with a board of trustees composed of Mr. Jul. Rosenwald (Chicago), president, Mr. Paul M. Warburg (New York), treasurer, Miss Henrietta Szold (New York), secretary and Dr. Cyrus Adler (Philadelphia), Mr. Sam S. Fels (Philadelphia), Judge Jul. W. Mack (Chicago), Dr. J. L. Magnes, Mr. Louis Marshall, Dr. Morris Loeb, Mr. J. B. Greenhut (New York) and Dr. O. Warburg (Berlin, Germany), members of the board.

This new experiment station is to be located at the foot of Mt. Carmel in Palestine, seven miles from Haifa, and is the first agricultural institution of research supported by private American capital to be established in a foreign country. The funds for the station have been furnished by several philanthropic Jews. Messrs. Jacob H. Schiff, of New York and Jul. Rosenwald, of Chicago, have furnished the first $20,000 necessary for the initial equipment. The minimum budget of $10,000 a year has been assured by Messrs. Schiff and Rosenwald, together with Mr. Paul M. Warburg (of Kühn, Loeb & Co.), Mr. Is. N. Seligman, Mr. Isidor Straus and others.

As an American institution in the Levant and carrying the American experiment station idea abroad, this newly incorporated instituton can not fail to interest American experiment station workers, since its purposes are the scientific study and development of the agricultural resources of one of the oldest parts of the old world, as rich in latent wealth as it is in historical and religious interest.

The director of this new station, Mr. Aaron Aaronsohn, is already known to quite a circle of experiment station workers, having spent a number of months in making comparative studies of the agricultural, climatic and botanical conditions of our southwestern country, for the purpose of comparing them with present conditions in Palestine, in which studies he has been deeply impressed with the remarkably close agricultural resemblance existing between California and Palestine. Mr. Aaronsohn is peculiarly well equipped to establish such an institution in Palestine, having spent fourteen years of his life in agricultural and botanical explorations throughout that region and having made himself familiar with Turkish, Arabic and

Hebrew, as well as French, German and English. He is a graduate of the Agricultural School of Grignon, France, and has attracted the attention of the scientific world through his discovery of the long-sought wild prototype of wheat. His discoveries in Palestine of drought-resistant stocks and dry land grains and forage plants, as well as the possibilities of American breeders utilizing his wild wheat, have led Dr. Galloway, the Chief of the Bureau of Plant Industry, to request Mr. Aaronsohn to prepare a bulletin, which is now in print, giving in some detail the bearing of his studies in Palestine on the many agricultural problems of the United States.

While the special aim of the institution will be to put the Jewish colonists and farmers of Palestine and the neighboring colonies in a position to carry on agriculture in a rational and progressive manner, Mr. Aaronsohn's idea is to assemble as complete an equipment of the official agricultural publications of the United States as possible. Through the liberality of the Office of Experiment Stations and the directors of various state stations, supplemented by private gifts and purchases, Mr. Aaronsohn has already assembled what will be the most complete set of American experiment station reports and bulletins to be found anywhere in the Old World. It is his earnest desire to make this set of American experiment station reports absolutely complete and he will keenly appreciate any help given him towards this end.

As the study of plant pathology is quite unknown in Palestine, Mr. Aaronsohn has purchased as a nucleus of pathological work the collection of the late Professor W. A. Kellerman of about 24,000 specimens of fungi, and the Department of Agriculture has offered to supplement this with about a thousand other numbers. To these American numbers Mr. Aaronsohn proposes to add his own personal collections of agronomic, botanical and geological material, and altogether they will prove of invaluable assistance in the comparative studies which he proposes shall be carried on at the station.

The buildings will be of stone and practically fireproof, but to give further guaranty against loss Mr. Aaronsohn proposes to install steel shelving for the books and metallic cases for his collections.

It is also Mr. Aaronsohn's purpose to have a visitors' laboratory, with proper facilities, which will be placed at the disposal of properly accredited visitors from abroad. Those who have taken advantage of the marvelous facilities of the Naples Zoological Station will appreciate how much this means in a country like Palestine, where there are few facilities for scientific investigation.

It is Mr. Aaronsohn's intention to publish at least the annual reports of his station in English, although naturally his circulars and bulletins containing the practical results will for the most part be published in Hebrew, Turkish and Arabic.

The founding with liberal financial support of this new station in the eastern Mediterranean region will go far towards introducing American methods in the study of agricultural problems throughout the whole Mediterranean region and facilitate the exchange of plant industries between that region and the United States, which has been already begun by the agricultural explorers of the department, and by such men as Dr. L. Trabut, the government botanist of Algeria, and which has proved of such mutual aid to both regions.

DAVID FAIRCHILD
U. S. DEPARTMENT OF AGRICULTURE

THE CARNEGIE INSTITUTION OF WASHINGTON[1]

THE Carnegie Institution of Washington has just issued its eighth "Year Book," a volume of about 250 pages, containing a résumé of the work accomplished under the auspices of the institution during the year 1909. The "Year Book" comprises the annual reports of the president, the executive committee and the directors of various departments of research, together with reports upon the progress of other investigations carried on by individual grantees and associates of the institution. There is also included a

[1] Statement supplied by the Institution.

bibliography of papers and reports on these investigations which have appeared in various journals during the year.

The report of the president gives detailed figures showing the funds available for expenditure during the year and the manner in which these funds have been distributed. A summary of these financial statements shows that of the $694,094.11 available, $467,500 have been applied to the maintenance of large projects and established departments of work; $49,969.32 have been distributed in the form of minor grants to individuals; $30,575.02 have been allotted to research associates and assistants; $54,645.27 have been expended in the work of publication and $49,792.21 have been required for administrative purposes. These allotments reached a total of $652,481.82, leaving an unallotted balance of $41,612.29 at the close of the fiscal year. The total amount of funds appropriated for expenditure from the foundation of the institution to the present time is $4,320,140.00, of which $307,227.03 were reverted and afterwards reappropriated. The total amount expended to date is $4,128,697.11.

The scope of the work undertaken by the institution has broadened until, as shown by the present report, investigations have been carried on in more than thirty different fields of research and extended into more than forty different countries. Two astronomical observatories and five laboratories are maintained, and the equipment of the various establishments located in different parts of the United States includes 58 buildings, a specially designed ship and 8 smaller craft.

The building designed for the principal offices of the institution has been completed during the past year and has been occupied by the administrative staff since the second week in November. It is located at the corner of Sixteenth and P Streets, in Washington, and contains, in addition to the executive offices, an assembly room with a seating capacity of 200 and ample space for the storage of publications. The annual meetings of the board of trustees will be held here, as well as the monthly meetings of the executive committee of the institution.

The building was dedicated on December 13, when addresses were delivered by Mr. Andrew Carnegie, founder of the institution and Hon. Elihu Root, chairman of the building committee. On this occasion also an illustrated lecture was given by Dr. George E. Hale, director of the Solar Observatory located on Mount Wilson, California, inaugurating a series of lectures which it is proposed to give annually. From December 15 to 17 the building was open to the public for inspection, and exhibits from the investigations of the ten departments of research, together with the work of publication and administration, were placed on view.

As a notable event of the past year the president cites the establishment and active operation of the observatory of the Department of Meridian Astrometry, at San Luis, in Argentina, under the direction of Professor Lewis Boss. The work of observation of the southern stars was begun in April last, and is now proceeding at a rate heretofore unequaled in this branch of astronomy. Observations made with the meridian-circle, transferred with great care to San Luis from the Dudley Observatory, in Albany, New York, will be combined with corresponding observations made at Albany.

Another event of prime importance during the year has been the completion and the initial cruise of the nonmagnetic ship *Carnegie*, now making a magnetic survey of the Atlantic Ocean, under the direction of the department of terrestrial magnetism. This ship was launched on June 12, 1909, and set sail upon her first voyage on August 21 last. During her voyage across the Atlantic errors of prime importance to navigation were found in the best magnetic charts now used by mariners.

At the Solar Observatory in California the 60-inch equatorial reflecting telescope has been tested and found highly satisfactory. The construction of a new tower telescope, 150 feet high above ground and 75 feet below ground, has been begun. In addition to the further interpretation of the nature of sunspots, it is expected that an investigation of the electro-magnetic properties shown by the

sun, in conjunction with observations made by the department of terrestrial magnetism on "storms" to which the earth's magnetism is subject, will result in a distinct advance in this field of research.

Capital results have been achieved also during the past year by other departments of the institution. At the Geophysical Laboratory in Washington, where geological and mineralogical experiments are being carried on, there has been an important addition to the equipment in the form of apparatus for subjecting materials under observation to high pressures and high temperatures. At the Marine Biological Laboratory at Tortugas, Florida, research has been widely extended by a corps of specialists. The equipment of the Nutrition Laboratory in Boston has proved highly effective in ascertaining the influence of nutrition upon pathological as well as upon normal subjects. The search for the sources of American history, which is being conducted by the department of historical research, has been vigorously carried forward in Mexico, Italy, France, Germany, Great Britain and the United States.

The investigations of the department of botanical research have been continued successfully. Among these the experiments of the director in the production of mutants in plants seem destined to play a fundamental rôle in the determination of the absorbing biological question of the derivation of species. The progress made in the researches in experimental evolution being conducted at Cold Spring Harbor has also been significant, and the facilities of this department have been increased by the purchase of Goose Island, in Long Island Sound, where the development of plants and animals in a state of isolation may be observed.

The publication work of the institution has proceeded actively. Nineteen volumes, with an aggregate of 4,907 pages, have been issued, bringing the total number of the institution's publications to 141, with a total aggregate of approximately 35,000 pages of printed matter. One of the most important publication projects thus far undertaken by the institution was inaugurated during the year, namely, that of an addition of the Classics of International Law. Under the general editorship of Professor James Brown Scott, the early master-works in international law are to be issued. Each work is to be reproduced by photographic process from the best available edition, and accompanied by a complete translation into English, and supplied with an introductory commentary. The work already begun includes the "Juris et judicii fecialis, sive juris inter gentes" of Zouche, and the "De jure belli ac pacis" of Grotius.

THE ROCKEFELLER FOUNDATION

As readers of SCIENCE have learned from the daily papers, a bill has been introduced into the United States Senate incorporating the Rockefeller Foundation, the object of which is "to promote the well-being and advance the civilization of the peoples of the United States and its territories and possessions, and of foreign lands, in the acquisition and dissemination of knowledge, in the prevention of suffering and in the promotion of any and all the elements of human progress." The bill names as incorporators of the foundation John D. Rockefeller, John D. Rockefeller, Jr., Fred T. Gates, Starr J. Murphy and Charles O. Heydt. The principal offices of the foundation would be in the District of Columbia, though the bill also gives the right to establish branch offices elsewhere and to hold meetings of the trustees at any place they may see fit. The amount of the endowment has not been announced. It is said that Mr. Rockefeller's gifts have amounted to about $150,000,000, and that his present fortune is in the neighborhood of $300,000,000.

SCIENTIFIC NOTES AND NEWS

DR. ADOLF VON BAEYER, professor of chemistry at Munich, has been elected a foreign member of the Paris Academy of Sciences.

THE following fifteen candidates have been selected by the council of the Royal Society to be recommended for election into the society: Mr. J. Barcroft, Professor G. C. Bourne, Professor A. P. Coleman, Dr. F. A. Dixey, Dr. L. N. G. Filon, Mr. A. Fowler, Dr. A. E. Garrod,

Mr. G. H. Hardy, Dr. J. A. Harker, Professor J. T. Hewitt, Professor B. Hopkinson, Dr. A. Lapworth, Lieutenant-Colonel Sir W. B. Lieshman, Mr. H. G. Plimmer, Mr. F. Soddy.

Professor G. E. Hale, Professor S. Arrhenius and Madame Curie have been elected honorary fellows of the Physical Society, London.

Dr. Hugo Münsterberg, professor of psychology at Harvard University, has been appointed exchange professor to lecture at Berlin in 1910–11.

The Academy of Scientific Men of Halle has awarded its gold Cothenius medal to Dr. Wilhelm Pfeffer, professor of botany at Leipzig.

The New York Academy of Sciences has appointed the following delegates to represent it at international congresses during the coming summer: Professors Hermon C. Bumpus, Bashford Dean and Henry E. Crampton for the Zoological Congress at Graz; Professors James F. Kemp, J. J. Stevenson and Dr. E. O. Hovey for the Geological Congress at Stockholm.

Professor Punnett, Mr. H. Gadow, King's, and Mr. A. E. Shipley, Christ's, have been appointed representatives of Cambridge University at the International Congress of Zoology to be held at Graz in August next. Mr. A. G. Tansley, Trinity, has been appointed to represent the university at the International Congress of Botany to be held at Brussels in May next.

Sir J. J. Thomson has been nominated to represent Cambridge University at the celebration next October of the centenary of the University of Berlin.

Sir William Preece, Sir Joseph Swan and Professor G. Vernon Harcourt have been elected the first honorary members of the Illuminating Engineering Society.

Dr. A. Hertzfeld, director of the Institute of Sugar Industry in Berlin, has been elected a foreign member of the Swedish Academy for Agriculture.

Dr. Edm. von Lippmann, Halle, has been given the honorary degree of doctor of engineering by the Dresden Institute of Technology.

The naturalists of France and of many other parts of the world are uniting in a jubilee celebration in honor of J. H. Fabre, styled by Charles Darwin "the immortal Fabre," and referred to by him also as "that inimitable observer." Fabre, after years of labor and of patient observation and of most important work, is, in his age, the most modest of men, leading a retired life, and his admirers everywhere and in all walks are uniting in this celebration. Not only are naturalists coming together for this jubilee, but prominent officials throughout France and prominent men in literature as well, since Fabre's published work possesses a high literary value. No one, says David Sharp, has ever written on his subjects with equal brilliancy and vivacity. So Mistral, the poet; Edmund Rostrand, the poet and dramatist, and Maurice Materlink, the naturalist, philosopher and novelist, among others, have united in this jubilee. Members of the French Academy engaged in other branches of science, such as Poincaré, and men prominent in many walks of life, not even excepting journalism, such as Hèbrard, the director of the *Temps,* have also associated themselves with Fabre's other admirers. The jubilee will be held on the third of April, at the time of the inauguration of the Institute of Oceanography by the Prince of Monaco. A medal will be struck in honor of the occasion. Americans wishing to contribute may send their subscriptions to Dr. L. O. Howard, permanent secretary of the American Association for the Advancement of Science, Smithsonian Institution, Washington, D. C. These should be sent at once, since the subscription closes the twenty-fifth of March.

Since the return of the DeMilhau Peabody Museum South American Expedition of Harvard University, Dr. William C. Farabee has received from the Universidad Mayor de San Marcos de Lima a diploma as honorary member of the faculty of sciences in the university, for "scientific merits and important services rendered to the government of Peru."

DR. J. K. SMALL, head curator of the museums and herbarium of the New York Botanical Garden and Mr. J. J. Carter, of Pleasant Grove, Pennsylvania, have spent about four weeks in botanical exploration of the unknown interior of the Andros Islands, thus completing the botanical survey of the Bahamian archipelago.

DR. J. E. MOORE, professor of surgery in the University of Minnesota, was seriously injured on February 25 by the fall of the temporary roof in the building where he was conducting a class in surgery. It is expected that he will recover. Nine students were more or less seriously injured.

THE New York alumni of the Johns Hopkins University held their annual dinner on March 2, when Dr. Simon Flexner, director of the Rockefeller Institute of Medical Research, presided.

PROFESSOR JAMES H. TUFTS, of the University of Chicago, will deliver a series of ten lectures on "Present Problems in Metaphysics and the Theory of Knowledge," before the department of philosophy, psychology and education of the Johns Hopkins University, March 9–19.

DR. W. S. FRANKLIN, professor of physics at Lehigh University, lectured before the Middletown Scientific Association of Wesleyan University on the "Practical Applications of the Gyrostat."

MR. F. W. DARLINGTON, of Pittsburgh, Pa., lectured before the electrical engineering students at the University of Minnesota on February 23 on "The Electrification of Steam Railways."

THE first discourse given on the new foundation of the Halley lecture at Oxford University will be delivered by the founder, Dr. Henry Wilde, F.R.S.

A TABLET in memory of Ross Gilmore Marvin, who was drowned in the Arctic Ocean on the Peary Polar expedition, will be unveiled in Sage Chapel, Cornell University, next month. Commander Peary will give the memorial address.

FOREIGN papers state that the inhabitants of Gross-Lichterfelde, the native place of Otto Lilienthal, have decided to erect a monument to the memory of their countryman, who was amongst the earliest practical pioneers in aviation, and met his death in 1896 while making a flight at Gömberg, in the province of Brandenburg. The monument will be erected either on the hill on the slopes of which Lilienthal made his early experiments, or in the square on the bank of the Teltour Canal.

THE Rev. G. F. Whidborne, known for his work in geology, died on February 14, at the age of sixty-four years.

COLONEL C. F. CONDER, of the British Army, who made important explorations in Palestine, died on February 16.

DR. HENRI DUFOUR, professor of physics at Lausanne, has died at the age of fifty-eight years.

THE following awards of the Mary Kingsley medal have, as we learn from *Nature*, been made by the Liverpool School of Tropical Medicine: Mrs. Pinnock, in recognition of the services rendered to the cause of tropical medicine and sanitation by her brother, the late Sir Alfred Jones, founder and first chairman of the school; Mr. W. Adamson and Professor W. Carter, for assistance rendered in the foundation of the school; Prince Auguste d'Arenberg, president of the Suez Canal Company, for his campaign against malaria at Ismailia; Sir William Macgregor, Governor of Queensland, for his services to sanitation and tropical medicine while governor of Lagos; Surgeon-General Walter Wyman, head of the Marine Hospital Service in the United States, for the organization which he has given to the service under him and for the manner in which he has always supported scientific principles in public sanitation; Sir Alfred Keogh, recently Director-General of the Royal Army Medical Corps, for the organization which he has given to the service under him and for the manner in which he has always supported scientific principles in public sanitation. The medal for valuable contributions to the scientific and educational side of tropical medicine has been awarded to Pro-

fessor R. Blanchard, Paris; Dr. A. Breinl, director of the Tropical Diseases Institute in Queensland; Professor A. Celli, Rome; Dr. C. W. Daniels, director of the London School of Tropical Medicine; Surgeon-Colonel King, Indian Medical Service; Professor Nocht, director of the Hamburg School of Tropical Medicine; Professor G. H. F. Nuttall, Quick professor of parasitology at Cambridge University; Major L. Rogers, Indian Medical Service; Professor J. L. Todd, associate professor of parasitology at McGill University.

FROM statistics published in the German press, giving for European countries the number of dirigible balloons and aeroplanes already finished at the end of 1909, or which will be ready for use very shortly, Consul Carl Bailey Hurst, of Plauen, quotes the following: Germany possesses 14 dirigibles of six different models—namely, Gross, Zeppelin, Parseval, Schütte, Siemens-Schuckert and the Rhine-Westphalian air ship—and five aeroplanes. France has seven dirigibles and 29 aeroplanes; Italy, three dirigibles and seven aeroplanes; Russia, three dirigibles and six aeroplanes; Austria, two dirigibles and four aeroplanes; England, two dirigibles and two aeroplanes, and Spain, one dirigible and three aeroplanes. Altogether, European nations have 32 dirigibles and 56 aeroplanes that are presumed to be available for service.

THE enterprise of German foresters and the importance of tree planting for forest purposes are shown by two items of news which come, the one from Montana, the other from Ontario. It is reported that a demand has developed for Montana larch seeds to be used by German nurserymen; while white pine seedlings are to be imported from Germany by the town of Guelph, Ont., for planting a 168-acre tract of land belonging to the municipality. The Germans recognize that the introduction into their forests of valuable trees native to other countries may be to their advantage. Although as a rule the forest trees best adapted to each region are those which naturally grow in it, there are many exceptions. Norway spruce and Austrian and Scotch pine have been carried from their native home to other parts of Europe and to America and have been found well worth the attention of the grower of timber. Several of our own species have met with favor in Europe and flourished there, such as the Douglas fir, black walnut and others. The Australian eucalyptus is proving a great find for America and South Africa. Our own white pine long ago crossed the Atlantic in response to the needs of Europeans, whose forests are comparatively poor in tree species, and is now grown commercially on such a scale that when it is wanted for planting in its own native habitat the German nurseryman is often ready to deliver young plants here for a lower price than our own nurserymen will quote. Now the Germans are going to try the Western larch also. The request from the German nurseryman instructs the collectors to gather the choisest seeds when ripe this fall. One nurseryman on Flathead Lake has offered to exchange larch seeds for seeds of desirable German shrubs, which he intends to cultivate and sell in America. In the same region, four or five months ago, foresters of our Department of Agriculture gathered seed for use in the neighboring Lolo Forest, where a new forest-planting nursery was begun last year. The objects of the Guelph planting are, according to local accounts, to protect the town's water source by a forest cover over its springs in the hills, to make a beautiful woods for a public park and to provide for a future timber supply as a municipal asset. In foreign countries, forest tracts are often owned and managed by towns and cities as a paying investment and to insure a permanent supply of wood for local consumption, but in America planting by municipalities other than for parks and for watershed protection has scarcely been thought of. The kinds of trees to be grown in the Guelph park have already been decided upon by the Ontario Agricultural College. The proposed reforestation promises to be of so great economic and sanitary value that the estimated cost of $8 per acre for importing

and planting the seedlings and caring for the growing trees is regarded as well worth while.

WE learn from *Nature* that the late Mr. R. Marcus Gunn, the eminent ophthalmic surgeon, who devoted much of the leisure of his vacations to making a collection of fossils, has left them to the British Museum (Natural History). He worked especially in the Jurassic formations of Sutherland, and at the time of his death was engaged in the preparation of a memoir on the Jurassic flora of Brora, in collaboration with Professor A. C. Seward, who is now completing the undertaking. He obtained many fish-remains, Mollusca and other fossils, which form a valuable addition to the national collection. Mr. Gunn also collected from the Old Red Sandstone of Caithness, and will always be remembered for his discovery of the problematical fossil fish *Palæspondylus gunni*, which was named after him by Dr. Traquair.

UNIVERSITY AND EDUCATIONAL NEWS

TUFTS COLLEGE has been made the residuary legatee under the will of John Everett Smith, and will, it is said, receive on the death of Mrs. Smith the sum of $500,000.

CHARLES ALFRED HASBROUCK, a well-known civil engineer, who died in California on February 1, bequeathed to Cornell University, from which he graduated in 1884, the farm at Forest Home, near Ithaca, on which he was born. His bequest to the university was made as a memorial to his wife, Mary Fobes Hasbrouck. In his will he expressed a wish that the property be used for the benefit of the women students of the university.

THE corporation and the board of overseers of Harvard University have created the department of university extension, and appointed in it the following officers: Dean, Professor Ropes; members of the administrative board for 1909–10, Professor Ropes, Professor Royce, Professor Hanus, Professor Hart, Professor Moore, Professor Osterhout, Professor Hughes and Professor Munro.

IT is announced that extension teaching on a large scale will be undertaken next year by Columbia University. The field to be covered will be broad. There will be classes organized in languages, literature, history, economics and politics; in various scientific subjects, including electrical and mechanical engineering; in architecture; in music and fine arts; in preventive medicine and sanitary science; in manual training and the household arts; in teaching, and in law. For this work a large staff of professors and lecturers will be appointed, chosen in part from the present teaching staff of the university. Professor James Chidester Egbert, director of the summer session, has been appointed director of extension teaching.

THE faculty of the University of Minnesota has inaugurated a movement to secure the erection of a suitable tribute from the people of the state of Minnesota to President Cyrus Northrop. It was decided that the tribute should take the form of a men's building to be erected upon the campus at a cost of not less than $400,000.

THE new recitation hall of Eastern College at Manassas, Va., erected at a cost of $35,000, was dedicated on February 22. Addresses were made by Dr. Elmer E. Brown, U. S. Commissioner of Education, Congressman Jones, of Virginia, and Dr. Hervin U. Roop, the president of the college.

PROFESSOR JOHN S. SHEARER, of the department of physics of Cornell university, is acting as a member of the Columbia University faculty during the rest of the present college year. Professor Wm. H. Hallock, head of the department of physics of Columbia University, will spend the period in Europe.

DR. LOUIS T. MORE, professor of physics, has been elected dean of the College of Liberal Arts of the University of Cincinnati.

MR. FRANK M. LEAVITT, now at the head of the department of manual training of the Boston city schools, has been appointed associate professor of industrial education in the School of Education of the University of Chicago.

MR. S. BRODETSKY, bracketted senior wrangler in 1908, has been elected to the Isaac Newton studentship at Cambridge University.

DISCUSSION AND CORRESPONDENCE

THE LENGTH OF SERVICE PENSIONS OF THE CARNEGIE FOUNDATION

EITHER as cause and effect or as a matter of mere time sequence, the writer has anticipated in this journal the most important actions taken by the trustees of the Carnegie Foundation at their two last annual meetings. There was printed in SCIENCE for April 24, 1908, correspondence with the president of the foundation urging that the pensions of widows of professors entitled to retiring allowances should be made a matter of right rather than a matter of optional favor, and at the meeting of the trustees in November this was done. It seems that this subject is not treated clearly by the president in his last annual report. Referring to the first adoption of the rules of the foundation he says:

> The underlying principles which seemed to be clear were these . . . (5) The retiring allowance system should embrace in its provisions the widows of teachers who under the rules had become eligible to retiring allowances. . . . A third rule provided for the pension for the widow of any teacher who, either on the ground of age or service, was entitled to a retiring allowance. These rules have now been in operation four years.

In the first annual report, however, it was explicitly pointed out that "In all cases, the granting of pensions to widows of professors stands upon a different basis than that of the awarding of retiring allowances to professors," and in the third annual report it is noted that "heretofore the pensions to widows have been only permissory."

I venture to note my service to my colleagues in this direction, as some of them think that I have performed a disservice in pointing out what seemed to me the dangers of the length of service pensions. In SCIENCE for April 2, 1909, I wrote:

> The reasons leading to the adoption of retirement after twenty-five years of service are obscure to me unless it is intended to relieve institutions of men whom they do not want to keep. . . . In order to reward a professor after long years of service, he should be relieved not of half of his salary and the privilege of teaching, but of so much routine instruction and administration as interfere with his research. . . . It may on the whole be regarded as fortunate that the Carnegie Foundation has not the means to continue these annuities for length of service. They will, I fear, tend to demoralize both the "humble and ill-compensated" professor and the "conspicuous" and much-tempted president.

My anticipations were soon justified by the troubles at the George Washington University, which retired on the foundation two of its professors against their will in order to save their salaries and because they did not agree with the policies of the administration, and which then was dropped from the list of institutions accepted by the foundation. I was, however, not less surprised than my colleagues to learn that the trustees of the Carnegie Foundation on November 17 had not only abolished the retiring allowance for length of service, but had made their action apply to those to whom the pensions had been promised.

This action would be absolutely incomprehensible if it were based on the grounds alleged by the president in his annual report, which has just now been printed. He does not even remotely refer to the financial inability of the foundation to carry out the obligations it had assumed, but bases his recommendation on the fact that he has unexpectedly discovered that presidents and professors take advantage of the rule, and that its effect is not "good" owing to "the opportunity which is thus opened to bring pressure to bear on the teacher, or by the tendency of the teacher assured of a retiring allowance to become ultra-critical toward the administration." This last clause throws a curious light on the administrative attitude—it would be dangerous to let the professor criticize the administration if thereby he risked losing only half of his salary and not all of it.

President Pritchett says: "The expectation that this rule would be taken advantage of almost wholly on the ground of disabilities has proved to be ill founded." But what warrant had the trustees for this expectation? The act of incorporation states that the object of the foundation is to provide retiring pensions for teachers who "by reason of long and

meritorious service, or by reason of old age, disability or other sufficient reason shall be entitled to the assistance and aid of this corporation." The rule adopted in regard to the first of the two classes of pensions specified in the act of incorporation reads: "Any person who has had a service of twenty-five years as a professor and who is at the time a professor in an accepted institution, shall be entitled to a retiring allowance computed as follows."

The change in the attitude of the president of the foundation has been as sudden as it is complete. In a letter to him, written on March 21, 1908, I said that the wisdom of the length of service pension was doubtful, and in his reply, intended for publication in SCIENCE and printed in the issue of April 24, 1908, he wrote:

> The provision for permitting a retiring allowance to be gained upon length of service seems also to us to add much to the value of the retiring allowance system. Under this provision a professor may, at the end of twenty-five years, retire on a stated proportion of his salary, the proportion increasing with each year of service. It is not likely that many professors will avail themselves of this provision. The man whose heart is in his teaching will not wish to give it up until a much later period. There are, however, teachers to whom this provision will be specially attractive, and that is to those who desire to spend the remainder of their active lives in scholarly research or literary work rather than in teaching. I can imagine no better thing for an institution of learning than to have about it a group of men who are engaged in active research and who are not burdened with the load of teaching which falls to most American teachers. In this way the retiring allowance will contribute directly to research.

Dr. David Starr Jordan, one of the trustees, is much franker than the president. He writes to the *Evening Post* that it seemed "financially impossible" for the foundation to meet the demands made on it under the rule. This is certainly a valid ground for not admitting to its privileges additional institutions or those not yet professors; but according to law resort must be had to the bankruptcy court when financial obligations can not be met. Whether the foundation is liable to those who have been financially injured by the change in the rule is an open question. Probably the only precedent is the case of Professor Capps against the University of Chicago, in which it was decided that a university can not alter its statutes to the financial disadvantage of a professor. It seems that it might be urged that the foundation has made an implicit contract with the professor. To encourage the advancement of teaching it promises certain rewards to those who perform certain services. Those who have performed the services can perhaps recover at law the payment promised. But whatever the legal obligation may be, the moral responsibility is obvious. President Pritchett writes that the "change will command the approval of the great body of devoted and able teachers." When he learns of his extraordinary error, he will, it may be hoped, recommend such modification of the new rule as will be accepted as equitable by those concerned.

The president of the foundation writes: "It is part of the invariable policy of the Carnegie Foundation to place in the hands of those interested in education the fullest details respecting the foundation and its administration." But it is not clear that the foundation has been entirely frank in the present instance. The official statement in regard to the rules signed by the secretary of the board of trustees reads:

> The rules as thus amended provide a retiring allowance for a teacher on two distinct grounds: (1) to a teacher of specified service on reaching the age of sixty-five; (2) to a teacher after twenty-five years of service in case of physical disability.
>
> Although these are the general rules governing retirement, the trustees are nevertheless willing to grant a retiring allowance after the years of service set forth in Rule 1 [Rule 2?] to the rare professor whose proved ability for research promises a fruitful contribution to the advancement of knowledge if he were able to devote his entire time to study or research; and the trustees may also grant a retiring allowance after the years of service set forth in Rule 1 [*sic*] to the executive head of an institution who has displayed distin-

guished ability as a teacher and educational administrator.

Dr. Jordan has printed the actual resolution adopted by the trustees, as follows:

It was also on motion, duly made and seconded, resolved that first, the executive committee be instructed to safeguard the interests of the following classes of cases: (*a*) those who have research work in view and have shown themselves unmistakably fit to pursue it; (*b*) those whose twenty-five years of service includes service as a college president; and (*c*) those in whose mind a definite expectation has been created by official action that they will be accorded the benefits of the foundation within the year 1910; and that, secondly, the executive committee be authorized to formulate regulations in accordance with these instructions.

It is difficult to reconcile the statement under (*a*) with the announcement of the secretary. In the case of (*b*) one can only reconcile the two versions by assuming that the presidents who make up the board believe that there can be no college president who has not "displayed distinguished ability as a teacher and educational administrator." It is not easy to guess a creditable reason for not having made (*c*) public, for it would not be honorable to conceal it in order to save the money due to those who might apply under the resolution if it were known to them.

It is certainly odd that a board of trustees consisting of university and college presidents should increase the maximum pension from $3,000 to $4,000, which can practically only be of advantage to the comparatively highly-salaried president, and should retain the privilege of retiring after twenty-five years, when this is denied to the professors through the financial inability of the foundation. But perhaps they assume that higher education can be best advanced by retiring the president whenever possible.

The lack of foresight and expert knowledge displayed by the president and trustees of the foundation is truly astounding. Mr. Carnegie wrote in his original letter to the trustees:

I have, therefore, transferred to you and your successors, as trustees, $10,000,000, 5 per cent. first mortgage bonds of the United States Steel Corporation, the revenue from which is to provide retiring pensions for the teachers of universities, colleges and technical schools in our country, Canada and Newfoundland under such conditions as you may adopt from time to time. Expert calculation shows that the revenue will be ample for the purpose.

In making his additional gift for tax-supported institutions, he wrote to the president:

I understand from you that if all the state universities should apply and be admitted, five millions more of five per cent. bonds would be required.

As a matter of fact, a million dollars will not support an adequate pension fund in a single large university—Yale already draws $35,000 a year—and if the state universities continue to develop, as at present, and retirement at sixty-five is made obligatory, five million dollars will not permanently suffice for a single university.

The increase in the appropriations of the foundation for pensions this year is $162,815, and the total appropriation for pensions is $466,320. The total income of the foundation last year was $544,355, and the administrative expenses were $53,584.85. After Mr. Carnegie gives the additional five million dollars, the income will soon be exhausted, even though one of the two objects of the foundation, as stated in the act of incorporation, may be abandoned.

J. McKEEN CATTELL

SCIENTIFIC BOOKS

Food Inspection and Analysis: For the Use of Public Analysts, Health Officers, Sanitary Chemists and Food Economists. By ALBERT E. LEACH, S.B., Chief of the Denver Food and Drug Inspection Laboratory, Bureau of Chemistry, U. S. Department of Agriculture, formerly Chief Analyst of the Massachusetts State Board of Health. Second edition, revised and enlarged. Cloth, $6\frac{3}{8} \times 9\frac{3}{4}$, pp. 954, Fig. 120; Pl. XL. New York, John Wiley & Sons; London, Chapman & Hall, Limited. 1909.

In 1904 the first edition of this book was published, and speedily found acceptance be-

cause of its high values for the purposes for which it was declaredly written. It is not, and does not pretend to be, a student's manual, a cyclopedia of its subject, a manual of the physiology nor of the technology of food. It is rather a compilation of the facts and methods that one of America's most experienced food analysts has found useful in his work and which he has thought might be helpful to others charged with similar responsibilities and encountering like problems. The merit of the work lies particularly in the fact that the compiler is recognized as a man of fair judgment and a critical analyst, who, from long experience, has come fully to realize, on the one hand, the facts that must be ascertained by analysis and the importance of the issues involved, and, on the other hand, the imperative need for the choice of methods capable of yielding safe results within a reasonable time and at such a cost as will make possible the performance of many similar analyses at moderate cost.

Since the publication of the first edition, many changes have arisen in the field covered by the book. The national food and drugs bill and the meat inspection bill of 1906 have become laws, and a large number of the states have established food controls. The number of chemists engaged in the work of food inspection has greatly increased. Under the leadership of the Association of Official Agricultural Chemists, new and improved methods have been devised. From 1903 to 1906, under authorization of congress, the Secretary of Agriculture has proclaimed standards for a large number of the staple foods, and, since the expiration of the specific authorization under which these standards were proclaimed, the Association of Official Agricultural Chemists and the Association of State and National Food and Dairy Departments, comprising in their membership all who are officially charged with the execution of the food laws of America and Canada, have formulated for the guidance of these officials and for public information, additional standards for other staple foods not represented in the proclamations of the Secretary of Agriculture. In the enforcement of the national law, many important regulations have been published. Meanwhile, investigations at home and abroad have developed many facts of importance in their bearing upon the subject, and those manufacturers of foods who have been induced by hope of gain or from sheer joy in the exercise of skill, to attempt to evade the meshes of the law, have resorted to new devices that have required detection and suppression where they were against the public interest.

After all these changes, any book published five years ago upon the subject of food inspection and analysis, is old. The food analysts of America have reason, therefore, for pleasure in the fact that Mr. Leach has undertaken the heavy labor of revising his book and of critically selecting the new matter required to bring it up to date; and also in the fact that, his own strength proving insufficient at present for the task, he has associated with him in the revision, Dr. Winton, formerly chemist of the Connecticut Agricultural Experiment Station and now chief of the Chicago Laboratory of the Bureau of Chemistry, a man of like skill and experience with himself, in whose judgment the food chemists of America have with reason come to trust.

The new edition is one fifth larger than the old. In its illustrations the changes are not numerous, but the condensation of old cuts has left room for the addition of a number of new figures of value, and several of the less representative cuts illustrating the histology of the cereals have been replaced by others based upon Dr. Winton's own excellent drawings. The increase in the size of the book is not due to the insertion of new chapters, although two new chapters upon the refractometer and upon flavoring extracts have been formed, in part from matter scattered through the body of the first edition and in part from new material. Nearly every page shows some paragraph improved by change of form or by addition of new matter. These changes are so numerous that space will permit the mention of no more than a few typical examples, such as the modern classification of nitrogenous constituents prepared for the book by Dr. Osborne, the more recent adaptations of

the immersion refractometer to food analysis, methods for the detection of viscogen in cream, Howard's methods for the analysis of ice cream, Robinson's methods for sausage analysis, Bigelow's work on meat extracts, methods for the detection of cold storage eggs, the more recent, simple methods for the determination of moisture in butter, Penfield's system of ash analysis, Bryan's work on starch in compressed yeast, the new sections on bleached flour, diabetic foods, prepared mustard, the Polenske number, methods of analysis for maple products, scientific standards of the International Congress of Sugar Chemists, on Neufeld's, Browne's and Van Dine's studies of honey, on Vasey's and Crampton and Tolman's studies of whiskey, besides the large amount of new matter in the pages upon flavoring extracts, the incorporation of the gist of the new official methods, of the more important food standards, and of the substance of the decisive national regulations. There are, of course, omissions of much that every analyst engaged in this work would be glad to have clearly stated and bound within the same covers; but even a thousand pages have their limits of content, and the matter for congratulation is that the revisers have chosen so well.

The temper of the book is worthy of note. Food adulterations and adulterants have, in these days, become the subject of discussions almost as warm as the importance of the matter merits, and the doctors as well as the writers of the press and laymen have been heard therein. But few echoes of these discussions appear in this book; dialectics have been avoided and mooted matters little discussed.

In a work of such magnitude, matter for criticism can always be found. One wonders why, for example, no mention is made of Horne's dry subacetate for clarification of saccharin liquids, that the Gutzeit method for the determination of arsenic is not presented in the principal section upon that subject, and that Kastle's excellent method for the identification of saccharin receives no mention.

It is deserving of more serious criticism that the official methods and standards are but partially stated, or are given in a modified form, without clear warning in the prefatory matter that for the full and exact statement of these methods and standards reference must be had to the corresponding official publications. The occasional note of departure from the letter of the text on these subjects is insufficient to acquaint the reader unfamiliar with the original texts of the extent and nature of the departures which the limitations of space and probably other excellent reasons have induced.

Deserving also of mention is the fact that this manual deals only with one side of the public analyst's work, and does not attempt the treatment of the forensic phase of his duties. Indeed, from one or two paragraphs in the general chapter of introduction, it may be inferred that the food analyst of America is unlikely to be called upon for very serious or complex work of the forensic character. Thus, in the first edition, the author notes that Massachusetts' experience had indicated that there was little need for the services of trained attorneys in the ordinary course of the enforcement of the food laws, since the trials involved hearings only before courts of magisterial grade where the services of a skilled inspector had proved more valuable than those of trained lawyers without special experience in the kind of causes at issue. In the second edition, this statement is modified to indicate that where the laws are new, the assistance of counsel may be needful.

The experience of the reviewer has compelled him to a very different judgment upon this point. Under present conditions, the real issue joined is not whether the small retailer in a single locality has violated the law and subjected himself to a moderate fine, but whether a given brand or even a given class of goods can safely be handled by any retailer in a large commonwealth. With relative frequency, therefore, food cases are tried in the higher courts with a large array of experts and counsel engaged on behalf of the real defendant, the manufacturer or group of manufacturers concerned; and every point, from the framing of the indictment and the

admissibility of evidence up to the constitutionality of the act is vigorously and skilfully contested on the defendant's behalf. The stress of the contest and the progress of the pure-food movement are such, moreover, that nearly every session of the legislature witnesses some change in the letter of the law that anew requires judicial construction; while decisions on established phraseology are being handed down by the bench in every commonwealth and by the federal courts. Furthermore, where the laws have assumed the civil form, the losses of cases arising from the unskilful preparation of the original records in the magistrates' courts and from the imperfect transcription of these records, have been sufficiently serious to warrant the employment of skilled legal assistance in even the first stages of the prosecution.

There is need therefore not only for legal aid of a high order, but also for the services of lawyers who have given special attention to food laws, the decisions relative thereto, and the general nature of the evidence they must elicit for the proper conduct of their cases. The public analyst should never be made to appear as the prosecutor, but should always be protected from the appearance, as well as the reality of such an attitude. His duty is that of the impartial judge within his own peculiar sphere, not that of the attorney.

For the reasons just set forth for the employment of skilled counsel in the service of food controls, it is likewise clear that the public analyst requires, if he is to be fitted for the highest usefulness in his sphere, special preparation for his forensic duties. It is to be hoped that on this side of his work, some manual will soon be written that shall have in that respect the same high degree of excellence that Mr. Leach's book exhibits on the laboratory side.

WM. FREAR

STATE COLLEGE, PA.,
February 8, 1910

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Pharmacology and Experimental Therapeutics, Vol. 1, No. 3, issued October, 1909, contains the following: "Experimental Criticism of Recent Results in Testing Adrenalin," by W. H. Schultz. The dilation time is a better index of the relative physiological activity of two adrenalin solutions than is the degree of mydriasis. "On the Relation between the Toxicity and Chemical Constitution of a Number of Derivatives of Choline," by Reid Hunt and R. deM. Taveau. Choline has been found widely distributed in plants and animals, but its function in the organism is yet unsolved. These authors point out that 0.00000001 gram acetyl choline will cause a fall in blood pressure and is only slightly toxic, so that its possibility in therapeutics, perhaps as a substitute for the nitrites, is suggested. "The Action of Adrenalin on the Pulmonary Vessels," by C. J. Wiggers. The difficulties in solving the problem are brought out. "A Clinical Study of Crystalline Strophanthin," by H. C. Bailey. Crystalline strophanthin is a valuable cardiac stimulant in broken compensation due to chronic interstitial nephritis or valvular heart disease. It should not be repeated in twenty-four hours. "The Life-saving Action of Physostigmin in Poisoning by Magnesium Salts," by Don R. Joseph and S. J. Meltzer. Physostigmin is capable of efficiently antagonizing some of the toxic actions of magnesium salts. This is mainly by its action on the respiration. "Note on the Amanita-Toxin," by W. W. Ford and I. H. Prouty.

Number 4 of the same journal issued January, 1910, contains the following articles: "Action of Urea and of Hypertonic Solutions on the Heart and Circulation," by J. A. E. Eyster and A. G. Wilde. In the mammal there is no striking difference evident and the effects of sodium chloride and glucose would seem to be approximately equal to those produced by a solution of urea of equal concentration. "The Inhibitory Action of Phenol on Absorption," by T. Sollmann, P. J. Hanzlik and J. D. Pilcher. Phenol checks intestinal absorption. This is proportionate to the amount of phenol absorbed. "On the Toxicity of Dextro-, Lævo- and Inactive Camphor," by W. E. Grove. The dextro- and lævo-rotatory

camphors differ only quantitatively in action. "Apparatus for Recording the Outflow of Liquids," by W. R. Williams. The mechanical description of an efficient method of recording secretions in physiological work.

RECENT PROGRESS IN METEOROLOGY AND CLIMATOLOGY

That interest in meteorology and climatology is increasing is shown by the advancement made within recent years, in the instruction offered in these fields by American colleges and universities. A comparatively few years ago only a few of the larger eastern universities included such courses among their sciences. At the present time, however, nearly every institution of note offers such electives, while in most agricultural schools these studies are included in the prescribed work. In some institutions, such as the Universities of Iowa and of Wisconsin, the courses are included in the work offered by the department of physics, while in others, notably Harvard and the University of Minnesota, they come under the supervision of the department of geology. A typical example of the rapid growth of interest in these sciences from an educational point of view is seen in the history of the courses in the last named institution. The first course in meteorology at the University of Minnesota was given by Professor C. W. Hall, head of the department of geology, in the spring term of the year 1906–7. This was a half-year course in elementary meteorology and the class numbered ten students, all of whom were juniors or seniors in the academic college. The numbers have grown and the interest has increased to such an extent that during the present school year a course covering one year, and including climatology, has been instituted by Professor E. M. Lehnerts, of the same department, who now has charge of the work. The class in the latter course now numbers seventy-six, of whom forty-seven are juniors and seniors in the academic department, and twenty-nine are freshmen and sophomores in forestry and agriculture.

The last number of the United States Weather Bureau's *Monthly Weather Review* in its accustomed form has recently been issued. As announced by Professor Willis L. Moore, the chief of the bureau, on March 12 last, the *Weather Review* will hereafter be "a monthly report of the weather and climatology of the country, and there will be excluded from its pages everything technical that is not of a purely climatological nature or a current report of weather conditions." While the change was doubtless made after careful deliberation, it is a change that students of meteorology will regret nevertheless, as it leaves the United States without a single meteorological journal of any kind. Although various American journals contain notes from time to time in meteorology and climatology, no magazine is devoted exclusively to these sciences, as are several in Europe. With our extensive weather service and with the increased interest in these fields within recent years, it would seem that the time is now ripe for the institution of a new journal as a private enterprise. Indeed, it is not improbable that the deceased *American Meteorological Journal* would meet with a hearty welcome if it should be resurrected.

Senór V. Castaneda, of the Mexican Weather Service, recently visited the United States for the purpose of studying the methods of distributing weather forecasts, storm warnings and the like, and also of the carrying on of other routine matters of a meteorological service. He spent part of September in the central office of the United States Weather Bureau in Washington, and then visited other stations of the bureau, going as far north as Boston, where he visited the Blue Hill Observatory. He is the second representative of the Mexican bureau to visit this country in such a capacity—the head of the service, Senór Manuel E. Pastrana, having been here for a considerable period three years ago. The object of his mission was to study the scientific basis of weather forecasting and the acquiring of the data from which the forecasts are made. The Mexican Weather Service has done some very creditable work, aside from the daily routine, the most important probably having been the preparation of a cloud

atlas which is now in the hands of the publisher. The bureau is also unique in that it is probably the only national service which attempts to forecast the weather for one month in advance. This feat is rendered somewhat simple, however, by the uniform character of the climate of Mexico.

THE weather service of Argentina under the direction of its chief, Mr. Walter G. Davis, a native of the United States, has expanded considerably within the past year. At present the stations at which simultaneous meteorological observations are made and communicated to the central office in Buenos Ayres form a network which covers all of the republic. Aside from this a beginning has been made toward the carrying on of research work. Mr. George O. Wiggin, the subdirector, also a native of the United States, recently was sent to this country for the double purpose of engaging a number of capable men to enter the service, and also to study the methods of investigating the upper atmosphere as practised by the Blue Hill Observatory and by the Mount Weather Observatory. He spent several weeks at each place, as did also several of the men whom he had obtained to assist in this work when it is begun in Argentina. Mr. S. P. Fergusson, of the former observatory, is now preparing a complete set of kite-flying apparatus for this part of the research work. When this equipment reaches its destination it is the hope of the director to have daily kite flights, similar to those now being carried on at Mount Weather. Such real progress must indeed be gratifying to all interested in the advancement of meteorology.

DURING the week beginning December 6, kites and balloons have been sent up simultaneously, for meteorological purposes, from about forty selected stations scattered throughout the world, including two in the United States—the Mount Weather Observatory and the Blue Hill Observatory. After the results obtained have been computed, they will be sent to the International Commission for Scientific Aeronautics in Strassburg, Germany, and it is expected that much will be learned from them concerning the movements of the upper atmosphere and their relation to conditions at the earth's surface. At the Mount Weather Observatory the work consisted of the usual daily kite flights, as no sounding balloon experiments were possible on account of a delayed consignment of balloons from abroad. At the Blue Hill Observatory pilot balloons were used on Monday and Tuesday, while sounding balloons were sent up from Pittsfield, Mass., under the personal direction of Professor A. Lawrence Rotch, the director of the observatory, on Friday, Saturday and Sunday. The pilot balloons are made of rubber and when filled with hydrogen gas expand to a diameter of about 75 cm. When one of these is liberated its altitude in degrees, together with its azimuth, are observed simultaneously, at the end of each minute, by means of transit instruments placed about a mile apart. From these observations the velocity and direction of the wind for all heights reached by the balloon while it remains visible, can be calculated. Occasionally such a balloon can be seen at both stations for over an hour, and the heights known to have been reached have exceeded ten miles in several instances. As no recording apparatus is attached to it, no attempt is made to recover the balloon, which either rises to a height where it bursts, due to the increased expansion as it rises, or is carried by the prevailing westerly winds aloft far out to sea. The sounding balloons, also made of rubber, are somewhat larger, being about 200 cm. in diameter when expanded, and carry a meteorograph which records the temperature and pressure of the air for all heights reached. They also carry a parachute, which, after the balloon bursts, brings the instrument safely to the ground. The basket covering the instrument bears a message to the finder asking him to return the apparatus intact to the Observatory, for which service he receives the sum of two dollars. Of the three balloons sent up from Pittsfield in the international series, only one of the recording instruments had been returned up to the time of this writing (January 1).

IN the investigation of the upper atmosphere Germany has always been the most ac-

tive, and the experiments carried on in this field by its scientific institutions continue to be an example for other nations to follow. Not only are daily kite flights made and pilot and sounding balloons sent up from a number of well-scattered stations in Germany, but expeditions to carry on similar work have frequently been sent to far distant lands. One such expedition only recently returned from a long and successful visit to equatorial Africa. During the recent international series of simultaneous upper air investigations, five such expeditions carried on these experiments in foreign countries. One of the latter, stationed in the Danish West Indies, carried on its work under the personal supervision of Professor H. Hergesell, one of the founders of, and still a leader in, aerial investigation. Frequently on these expeditions the sounding balloons are sent up from a ship out in a large body of water. The balloons are followed by the ship until they burst, and when the parachute brings the apparatus back to the water surface the instrument and records are immediately recovered.

WHILE polar exploration generally is not primarily for meteorological purposes, the data obtained often contribute greatly to our knowledge of atmospheric conditions in these parts of the earth. It might be said that next to the accounts of previously unvisited lands the meteorological data obtained on these expeditions probably form the most valuable information. Especially important are these data when they contribute information concerning the planetary winds and pressures. Temperature data, while very interesting, are not so important. That the polar regions offer exceptional opportunities for meteorological research is recognized by Count Zeppelin, who is making plans to explore the entire north polar region by means of an airship. In this formidable plan the idea of reaching the pole is only incidental, the enterprise in this case being primarily meteorological. A new British Antarctic expedition is also being organized by Captain R. Scott, the leader of the expedition in the *Discovery*. The meteorological observatons obtained in this expedition, which is to begin the coming summer, will undoubtedly add greatly to our knowledge of Antarctic conditions.

THE relation between meteorology and aeronautics is so close that one does not advance without having a similar effect upon the other. While it is true that the former science has not advanced so rapidly during the last two years as has the latter, its advancement has undoubtedly been accelerated by the great progress made in the science of navigating the air. The close union of the two is seen in the following list of names of men prominent in both fields: Hergesell, Zeppelin, Süring, Berson, Rotch, Clayton and Hersey. The men who are really the cause of the recent progress in aeronautics have frequently found it profitable to consult meteorological authorities as to the atmospheric conditions with which an airship has to contend. Moreover, Wilbur Wright, in a recent interview is reported to have said that the progress of the next two years in the art of flying will be largely progress in manipulation and navigation, not in construction, as the past two years have been. In other words, it was his opinion that progress in the immediate future would be in the controlling of the air craft in various atmospheric conditions, rather than in the details of construction—a prophecy which clearly shows the cause of the close relation between the two sciences. Again, Hubert Latham, the well-known foreign aviator, who for a time held the record for height attained by an aeroplane, is quoted as saying that it is easier to navigate the air at moderately great heights than at low heights, because of the steadier, though stronger winds aloft, the varying winds near the surface being as dangerous for an aeroplane as the waves and eddies in the water near a coast are for a ship. A knowledge of such characteristics of the atmosphere is thus of importance in both sciences.

DURING the past year the United States Weather Bureau has, from time to time, issued a long-range forecast of the weather for the whole of the United States—one forecasting the weather conditions expected for the follow-

ing seven days. Considering the difficulty of the problem, the forecasts have been remarkably successful. While the percentage of accuracy of these forecasts has naturally not been so great as the high standard reached and maintained by the daily forecasts, a good beginning has been made. Doubtless the researches carried on at Mount Weather, especially the upper-air investigation, are already beginning to bear fruit. Meteorological research under the auspices of the United States Weather Bureau is still in its infancy, and no one can tell what may be learned when it has progressed a few years longer. The upper-air investigation gives promise of most desirable results. The daily kite flights under the direction of Dr. William R. Blair have been very successful, the average height obtained being great, while the world's record for height reached by a kite is still held. Since in these experiments the data obtained include temperatures only, it is to be hoped that the other meteorological conditions at the kite may also be obtained. Sounding-balloon experiments have been instituted with fair success by the bureau during the past summer, Omaha and Indianapolis having been selected for the work on account of their central location. It is probable that more of this valuable work will be carried on during the coming year.

As to what may be accomplished for meteorology by men who are thoroughly interested in the science, the history of the Mount Rose Weather Observatory is a striking example. The history of this project is the history of the zeal of a professor of Latin, Professor J. E. Church, Jr., of the University of Nevada, and that of a few of his colleagues whom he interested in the work. The observatory is an automatic one, located upon the summit of Mount Rose, a mountain 10,800 feet in altitude, situated sixteen miles southwest of Reno, Nevada. Begun in 1905, when maximum and minimum thermometers were placed there to obtain further data on summit temperatures in the Sierra Nevada in winter, it was discovered soon afterward that "frost forecasts could be made with considerable certainty from the mountain top in advance of instrumental indications below." This discovery led the Nevada Agricultural Experiment Station in June of the following year "to offer a provisional appropriation of $500 under the Adams Act to supplement the independent effort of the faculty of the university." Following this the work formally became and has continued to be the department of meteorology and climatology of the Nevada Agricultural Experiment Station, with Dr. Church the cooperative observer. Owing to the extremely hazardous transportation, the work of construction proceeded with difficulty, but before the advent of winter the building was completed and some instruments installed. Of the latter the most interesting was a precipitation tank thirty inches in diameter and four feet high with an intake pipe eight inches in diameter and thirty feet long. This instrument was of great value in ascertaining the total amount of snow falling during the winter season, making it possible to estimate the probable amount of water available for irrigation purposes during the following summer. Considering the inaccessibility of the observatory, the records obtained have been fairly complete and are extremely interesting. The instrumental difficulties encountered are summed up by Dr. Church in his last report in which he says: "The perfecting of an automatic meteorograph which will successfully record the weather conditions at high altitudes is the necessary antecedent to a more thorough knowledge of mountain meteorology, and it is at present the most important problem of the observatory." To overcome this problem, Mr. S. P. Fergusson, of the Blue Hill Observatory, who designed and constructed the meteorograph placed by Harvard on El Misti, Peru, was engaged to build a somewhat similar one for the Mount Rose Station. This was completed in due time and, after having been tested at the University of Nevada, it was permanently installed upon the summit of the mountain. While progress was handicapped awaiting the completion and installation of the necessary apparatus, investigations were carried on based upon the records already obtained on

the mountain. Of these the more important were the general climatology of Mount Rose, the relation of climate to the plant environment, the relation of timber to the conservation of snow, and the frost forecasting from the summit. With such a record for its short life, and with ambitious plans for the future, progress is certain to be the result. Having recently been assured of further support by the office of experiment stations of the national government, the zealous workers are almost certain to produce results which will be of great value to meteorology in general and to the agricultural interests of the Great Basin in particular.

Andrew H. Palmer
Blue Hill Observatory,
Hyde Park, Mass.

CONCERNING THE DATE OF THE LAMARCK MANUSCRIPT AT HARVARD

A curious mistake has found its way into M. Landrieu's "Life of Lamarck" regarding the probable date of the Harvard manuscript to which I referred in the March number of the *American Naturalist*. In this article I had stated that the "Manuscrits de Lamarck" were "*brought together* in a volume, the binding dating 1830–40," and that in this little volume there was "a table of contents, probably in the hand of the *early owner* [this does not mean the *author*] of the manuscript." Also that "it will be noted that the papers were *collected* before 1835, the year of the appearance of the second edition of the 'Animaux sans Vertèbres,'" because in the table of contents, referred to above as "in the hand of the early owner" "it is stated that the drawings *will form* part of the second edition" of that work.

Now M. Landrieu remarks in perfect seriousness that I have given the probable date of the *writing* of the manuscript "as before 1835," at which time, as he notes, "Lamarck had been dead six years, after ten years of total blindness!" So I must now smilingly protest that I was aware of the date of Lamarck's death, and even when his eyesight failed him—in fact I mentioned the latter date, as 1818, in the same *Naturalist* paper (p. 148) which my colleague has so imperfectly read. The year 1835 is but a landmark in the Harvard manuscript, since it was at that time or somewhat before that time that its five component parts were brought together in a little volume by the "early owner," who may well have been an editor of the second edition of the "Animaux sans Vertèbres." If, moreover, my good friend M. Landrieu had interpreted the *Naturalist* paper carefully, he might have discovered that I have given the probable dates of various parts of the Harvard manuscript as prior to 1818, "the year in which Lamarck's eyes failed him." So, after all, M. Landrieu's estimate of the date of these manuscripts and my own do not differ widely. He gives the dates between 1810 and 1820—thus he is even less conservative than myself, for he assumes that Lamarck may have continued to write his papers *propria manu* even after his eyesight failed.

Bashford Dean

SPECIAL ARTICLES

THE INTERFERENCE OF THE REFLECTED DIFFRACTED AND THE DIFFRACTED REFLECTED RAYS OF A PLANE TRANSPARENT GRATING, AND ON AN INTERFEROMETER

If parallel light, falling on the front face of a transparent plane grating, is observed through a telescope after reflection from a rear parallel face the spectrum is frequently found to be intersected by strong vertical interference bands. Almost any type of grating will suffice, including the admirable replicas now available, like those of Mr. Ives. In the latter case one would be inclined to refer the phenomenon to the film and give it no further consideration. On closer inspection, however, it appears that the strongest fringes certainly have a different origin and depend essentially on the reflecting face behind the grating. If, for instance, this face is blurred by attaching a piece of rough wet paper, or by pasting the face of a prism upon it with water, so as to remove most of the reflected light, the fringes all but disappear. If a metal mirror is forced against the rear

glass face whereby a half wave-length is lost at the mirror but not at the glass face in contact, the fringes are impaired, making a rather interesting experiment. With homogeneous light the fringes of the film itself appear to the naked eye, as they are usually very large by comparison.

Granting that the fringes in question depend upon the reflecting surface behind the grating, they must move if the distance between them is varied. Consequently a phenomenon so easily produced and controlled is of much greater interest in relation to micrometric measurements than at first appears and we have for this reason given it detailed treatment. It has the great advantage of not needing monochromatic light, of being applicable for any wave-length whatever and of admitting of the measurement of small horizontal angles.

When the phenomenon as a whole is carefully studied it is found to be multiple in character. In each order of spectrum there are different groups of fringes of different angular sizes and usually in very different focal planes. Some of these are associated with parallel light, others with divergent or convergent light, so that a telescope is essential to bring out the successive groups in their entirety. At any deviation the diffracted light is necessarily monochromatic; but the fringes need not and rarely do appear in focus with the solar spectrum. If the slit of the spectroscope is purposely slightly inclined to the lines of the grating, certain of the fringes may appear inclined in one way and others in the opposite way, producing a cross pattern like a pantograph. The reason for this appears in the equations.

In any case the final evidence is given when the reflecting face behind the grating is movable parallel to it. The principal fringes of the interferometer so obtained are subject to the equation (air space e, wave-length λ, angle of incidence i, of diffraction θ'),

$$\delta e = \lambda/2(\cos\theta' - \cos i),$$

and it is therefore less unique as an absolute instrument than Michelson's classic apparatus or the device of Fabry and Perot. Its sensitiveness per fringe depends essentially upon the angle of incidence and diffraction and it admits of but 1 cm. (about) of air space between grating face and mirror before the fringes become too fine to be available. But on the other hand, it does not require monochromatic light (a Welsbach burner suffices), it does not require optical plate glass, it is sufficient to use but a square centimeter of grating film, and it admits of very easy manipulation, for painstaking adjustments as to normality, etc., are superfluous. In fact, all that is needed is to put the sodium lines in the spectrum reflected from the grating and from the mirror into coincidence both horizontally and vertically with the usual three adjustment screws on grating and mirror. Naturally sunlight is here desirable. Thereupon the fringes will usually appear and may be sharply adjusted on a second trial at once.

When the air space is small, coarse and fine fringes (fluted fringes) are simultaneously in focus, one of which may be used as a coarse adjustment on the other. Finally the sensitiveness per fringe to be obtained is easily a length of one half wave-length in the fine fringes and one wave-length in the coarse fringes, though the latter may also be increased almost to the limit of the former.

C. BARUS,
M. BARUS

BROWN UNIVERSITY,
PROVIDENCE, R. I.

THE EFFECT OF ASPHYXIA ON THE PUPIL[1]

IN a recent communication to the Society for Experimental Biology and Medicine (p. 49, December 16, 1908) Dr. John Auer stated that the "Myotic effect of asphyxia in frogs is interesting, as asphyxia in mammals produces chiefly dilatation." We were surprised at this statement, as we had a different impression from having observed the pupils of various animals during asphyxia. As such observations are usually recorded we examined our protocols, and finding our impression con-

[1] From the physiological laboratories of Washington and Pittsburgh universities.

firmed, we have made a few additional observations in order to completely satisfy ourselves in the matter. Having gathered the data, we feel that it should be reported, since we find but slight mention of the phenomena in current physiological treatises we have had the opportunity to examine.[3] We have exhausted the available original sources at our command and very little has been found. We have the impression that very thorough observations have long since been made and recorded, but in view of the above conditions we feel justified in recording briefly our observations in order to recall attention to the phenomena. We may add that we hope to more thoroughly exhaust the literature as opportunity affords, and if it then seems desirable, to publish our results in greater detail.

Our data show that in all animals observed, only momentary or no dilatation of the pupils occurs during the first stage of rapid asphyxia (*e. g.*, by bleeding or by clamping the trachea or by insufflating the lungs with carbon dioxide or hydrogen gas), and that as a rule a *very marked constriction* of the pupils occurs during this stage. We have observations on sheep, rabbit, guinea pig, squirrel, rat, mouse, dog, cat, chicken, guinea fowl, pigeon, dove, sparrow and snake. As yet our data are incomplete on the effect of section of the nerves governing the pupil on the asphyxial changes.

It is interesting to note the post mortem differences observed in the size of the pupils in different animals, *e. g.*, cats show wide dilatation, while common gray rabbits, as a rule, show marked constriction. It is known that the eye (excised) of a frog or eel constricts its pupil on exposure to light, and dilates it in the dark; and that even the isolated iris of the eel contracts in the light.[4]

[3] For example, Starling, "Text-book of Physiology," p. 404, 1907, merely mentions constriction of the pupils in early stages of asphyxia; Paton, "Essentials of Human Physiology," 1905, p. 306, states that in the initial stage of acute asphyxia the pupils are small, while a number of writers do not mention it at all.

[4] Stewart, "Manual of Physiology," fifth edition, p. 798.

Photic stimulation, the "at rest" condition of the pupil, etc., obviously should be taken into consideration in drawing conclusions on the size of the pupil in the eyes of dead animals or in excised eyes.

C. C. Guthrie,
F. V. Guthrie,
A. H. Ryan

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SECTION D

Profiting by the experience of former meetings and in accordance with the actions of the council and section at the Baltimore meeting, the chairman and secretary of Section D, in arranging the program for the Boston meeting, had in mind, in addition to the accommodation of papers volunteered by the members at large, a program, to be covered in a small number of sessions and in the compass of two days, which should provide: (*a*) a "general interest" session, including the address of the retiring vice-president; (*b*) a series of solicited papers on aeronautics and related subjects; (*c*) a joint session with Sections A and B.

As a result of the plans thus formulated, the section held a session on Tuesday morning, December 28, at which in addition to the business of the organization and election of officers, papers on miscellaneous subjects were presented; a session on Wednesday morning, devoted to papers on aeronautics, and the general interest session on Wednesday afternoon. On Tuesday afternoon the members of the section attended a joint session of Sections A and B.

Professor A. Lawrence Rotch was elected chairman of the section and a vice-president of the association for 1910; Professor W. J. Humphreys, member of the sectional committee for five years; President F. W. McNair, member of the council for 1910, and Mr. A. M. Herring, member of the general committee for the Boston meeting.

Vice-president J. F. Hayford presided at all meetings of the section. The program in detail is given herewith:

TUESDAY A.M., DECEMBER 28

"Some Notes on the Cutting of Music Rolls and on a New Machine for Making Master or Pattern Rolls," J. F. Kelly, Pittsfield, Mass. (Presented by Walter Reed.)

"A Pitot Tube Steam Meter," E. H. Lockwood, New Haven, Conn.

"Production Engineering," A. A. Hamerschlag, Pittsburgh, Pa. (Presented by the secretary.)

"Recent Improvements in Ore Concentration Machinery," R. H. Richards, Boston, Mass.

"A Parallel Rule," H. E. Wetherill, Philadelphia, Pa. (Read by title.)

"The Photographic Lens as an Engineering Instrument," E. H. Berry, East Orange, N. J. (Read by title.)

WEDNESDAY A.M., DECEMBER 29

"The Changes of the Wind with Altitude," A. J. Henry, Mount Weather, Va. (Presented by W. J. Humphreys.)

"Wind Pressure and Velocity," S. P. Ferguson, Hyde Park, Mass.

"The Relation of Wind to Aeronautics," A. Lawrence Rotch, Hyde Park, Mass.

"Turbulent Surface Winds," W. J. Humphreys, Washington, D. C.

"Aerodynamics," A. M. Herring, New York, N. Y.

"Vertical Air Currents and their Office in Supporting a Moving Aerofoil," F. W. Very, Westwood, Mass.

"The Center of Pressure on Arched Surfaces," M. B. Sellers, Fireclay, Ky. (Read by title.)

"Interference of Aeroplane Surfaces due to Grouping," M. B. Sellers, Fireclay, Ky. (Read by title.)

"Vagaries of Air Currents," A. T. Atherholt, Philadelphia, Pa. (Read by title.)

"The Pneumodynamic and the Thermodynamic Function," J. M. Siebel, Chicago, Ill. (Read by title.)

"General Design for an Aerial Machine of High Speed and Efficiency," David Todd, Amherst, Mass. (Read by title.)

"Some Applications of the Laws of Aerial Viscosity to Problems of Aviation," F. W. Very, Westwood, Mass. (Read by title.)

WEDNESDAY P.M., DECEMBER 29

Vice-presidential address[1]—"The Profession of Engineering and its Relation to the American Association for the Advancement of Science," G. F. Swain, Boston, Mass.

"The Development of the Modern Textile Mill," C. J. H. Woodbury, Boston, Mass.

"The Present Status of Aerial Navigation,"[2] Octave Chanute, Chicago, Ill.

The meetings of the section were well attended, the papers were valuable contributions and the discussions interesting. Those responsible for the program appreciate the efforts of the members who prepared and presented the papers and feel that the meeting was in all respects very encouraging.

G. W. BISSELL,
Secretary

EAST LANSING, MICH.

[1] Published in full, SCIENCE, February, 1910.

[2] To be published in full in SCIENCE.

THE AMERICAN PHYSIOLOGICAL SOCIETY

THE twenty-second annual meeting of the American Physiological Society was held in the physiological laboratories of the Harvard Medical School, Boston, Mass., December 28–30, 1909. Sixty-nine of the one hundred and sixty members of the society were in attendance. The officers of the meeting were W. H. Howell, president, and R. Hunt, secretary.

The following papers and demonstrations occupied the six scientific sessions:

JOINT MEETING WITH SECTION K—PHYSIOLOGY AND EXPERIMENTAL MEDICINE—AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

Address of the retiring vice-president—"Chemical Regulation of the Body-processes by Means of Activators, Kinases and Hormones," W. H. Howell.

Symposium on Internal Secretion:

"A General Review of the Chemical Aspect of Internal Secretion," R. H. Chittenden.

"The Internal Secretion of the Pancreas," W. G. McCallum.

"Our Present Knowledge of Thyroid Function," S. P. Beebe.

"Metabolism after Parathyroidectomy," J. V. Cooke.

"Physiological Consequences of Total and of Partial Hypophysectomy," H. Cushing.

JOINT SESSION WITH THE AMERICAN SOCIETY OF BIOLOGICAL CHEMISTS

"On the Reversible Reaction for the Liberation of Carbonic Acid from the Blood in the Lung," L. J. Henderson.

"The Action of Certain Substances on the Respiratory Center," A. S. Loevenhart (with W. E. Grove).

"Some Reactions of Lipase of Human Pancreatic Juice," H. C. Bradley.

"The Action of the Blood Proteins on the Isolated Mammalian Heart," W. H. Howell (for L. W. Gorham and A. W. Morrison).

"The Absorption of Fluid from the Peritoneal Cavity," L. Loeb (with M. L. Fleisher).

"The Distribution of Glycogenolytic Ferment in the Animal Body," J. J. R. Macleod.

"Sugar Production from Amino-acids in Metabolism," A. I. Ringer and G. Lusk.

"Further Studies on the Internal Secretion of the Thyroid," A. J. Carlson and A. Woelfel.

"Metabolism of Purin Derivatives," L. B. Mendel and J. F. Lyman.

"The Relation of Ptyalin Concentration to the Diet and to the Rate of the Secretion of Saliva," A. L. Crittenden and A. J. Carlson.

"The Action of Isotonic Solutions of Neutral Salts on Unfertilized Echinoderm Eggs," R. S. Lillie.

"The Food Requirements for Growing Children," E. W. Rockwood.

"The Sensitizing and Desensitizing Action of Various Electrolytes on Muscle and Nerve," R. S. Lillie.

"Sudan III. and the Absorption of Fat," R. H. Whitehead.

"The Effect of Inanition and of Various Diets upon the Resistance of Animals to Certain Poisons," R. Hunt.

"Do Muscle and Blood Serum contain Kreatinin?" P. A. Shaffer.

PAPERS PRESENTED AT THE OTHER SESSIONS

"The Effect of External Temperature upon the Peripheral Circulation," A. W. Hewlett.

"The Effect of Exercise upon Venous Pressure," D. R. Hooker (with J. M. Wolfsohn).

"Changes in the Heart during Hemorrhage," C. J. Wiggers.

"On the Relation of the Vasomotor Center to Afferent Impulses," W. T. Porter.

"Effect of Stimulation of the Splanchnic Nerve on the Glycogenolytic Ferments of Lymph and Blood," J. J. R. Macleod.

"The Influence of Alcohol on Metabolism," L. B. Mendel (with W. W. Hilditch).

"The Summation of Stimuli," F. L. Lee (with M. Morse).

"Influence of Ethyl Alcohol upon the Life Cycle of Paramœcium," C. F. Hodge (with W. A. Matheny).

"The Influence of Thyroid-parathyroidectomy on the Ammonia-destroying Power of the Liver," A. J. Carlson (with Clara Jacobson).

"Energy Metabolism in Parturient Women," T. M. Carpenter and J. R. Murlin.

"Mammalian Heart Strips together with a Theory of Cardiac Inhibition," J. Erlanger.

"The Velocities of some Physiological Actions," C. D. Snyder.

"On the Mode of Action of the Glomerulus of the Kidney" (with demonstration), T. G. Brodie.

"Apnea Vera in Anesthesia," M. M. Scarborough and Y. Henderson.

"The Cortico-spinal Tract in the Rat," J. L. Kin .

"On Protein Assimilation," P. A. Levene (with G. M. Meyer).

"On the Condition of the Spinal Vaso-motor Pathways in Shock," F. H. Pike.

"The Influence of Dietetic Alterations on the Types of Intestinal Flora," C. A. Herter (with A. I. Kendall).

"Observations upon the Blood Pressure of the Sheep under Local and General Anesthesia," M. Dresbach.

"On the Distribution of Antibodies in Normal and Immune Animals," L. Hektoen and A. J. Carlson.

"On the Cause of Diurnal Variation in Body-temperature," S. Simpson.

"The Pressure of Bile Secretion in the Herbivora," S. Simpson.

"Microscopical Structure of the Neurite," C. F. Hodge (with H. B. Davis).

"Respiratory Waves of Blood Pressure in Man," J. Erlanger (with E. G. Festerling).

"Further Studies on the Influence of Copious Water Drinking with Meals," P. B. Hawk.

"An Observation on the Chemical Regulation of Respiration," Y. Henderson.

"The Gaseous Metabolism of the Heart during Vagus Inhibition," W. H. Howell (for J. M. Wolfsohn and L. W. Ketron).

"Congenital Thyroidism; an Experimental Study of the Thyroid in Relation to Other Glands of Internal Secretion," R. G. Hoskins.

"The Primitive Movements of the Vertebrate Embryo," S. Paton.

"The Action of Urea upon the Heart," F. P. Knowlton.

"Physiological Effects of the Marathon Race, Circulatory and Renal Systems," J. H. Barach (with J. W. Boyce and W. L. Savage).

"The Relation of the Pancreas to Sugar Metabolism," W. M. Baldwin.

"Some Urinary Findings in Eclampsia," L. B. Stookey. (Read by title.)

"The Action of Magnesium Salts on Internal Respiratory Processes," C. C. Guthrie. (Read by title.)

DEMONSTRATIONS

E. G. Martin: Some apparatus used in the quantitative study of faradic stimuli.

W. B. Cannon: Nerve cells of the myenteric plexus subjected to anemia for different periods.

W. B. Cannon: The influence of tonus on peristalsis.

Y. Henderson: Demonstration of a simple gas meter.

D. R. Joseph and S. J. Meltzer: The mutual antagonism between magnesium and barium.

J. Auer (with P. Lewis): Demonstration of anaphylactic immobilization of the lungs in guinea-pigs.

W. H. Schultz: A simple respiration apparatus.

S. J. Meltzer: A demonstration of the method of respiration by continuous intratracheal insufflation.

In the afternoon of December 29 the members of the society visited the Carnegie Nutrition Laboratory, where demonstrations were given by Dr. F. G. Benedict and assistants.

Owing to the rapidly increasing number of active workers in physiology in this country and the consequent growth of the society, the number of papers presented at the annual meetings has now become so great that their reading and adequate discussion in the time allotted for the meeting is practically impossible. In the hope of remedying this situation, at least in part, it was voted to limit henceforth the time of presentation of all papers to ten minutes, and that abstracts of the papers be furnished the secretary in time for printing before the meetings. It is hoped that with printed abstracts of the papers in the hands of every member attending, less time will be required for their presentation and more time given to the discussions.

An appropriation of $50 was voted for the fund now being raised by the French physiologists for the erection of a monument to Marey.

The following new members were elected: F. C. Becht, of the University of Chicago, and J. B. Leathes, of the University of Toronto.

The president appointed the following delegates to the International Zoological Congress at Graz: R. G. Harrison and A. J. Carlson; to the International Congress of Physiologists at Vienna: R. Hunt and A. J. Carlson.

Officers for the ensuing year:

President—W. H. Howell.
Secretary—A. J. Carlson.
Treasurer—W. B. Cannon.
Additional Members of the Council—J. Erlanger and F. S. Lee.

A. J. CARLSON,
Secretary

THE UNIVERSITY OF CHICAGO

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT the 442d regular meeting, held February 15, 1910, Miss Rovena Buell, of the American School for Classical Studies at Rome, presented a paper on "Amulets," illustrating her discourse with interesting specimens collected by herself chiefly in Italy. In the making of this collection of Italian amulets the effort has been to bring together those in modern use and their ancient parallels. The sixty specimens may be roughly divided thus:

1. Prophylactics against the evil eye, having in form some relation to a horn and representing phallicism, Diana worship, and defensive symbolism by means of the hand. Examples—a phallus, a tiger's claw, a boar's tusk, a crab's claw, coral and shell horns, lunar crescents, composite horned animals, hands making the sign of the *fico* and the sign of the horns.

2. Amulets that make the sound of metal, hateful to evil spirits. Examples—bells, clashing disks and pendants.

3. Grotesque and ocular guards against malevolence. Examples—masks, a humpback, compositions or stones resembling eyes.

4. Preventives and cures by suggestion. Examples—a fossilized trochus, "eye of Santa Lucia," for eye maladies, a limonite concretion with a loose inner particle, "*pietra gravida*," for miscarriage, fossilized corals, "witch stone," for witch spells, carnelian and jasper, "blood stones," for heart disease and hemorrhages, bronze and silver fish, for female sterility, a comb, for caked breasts (caused by the presence of a witch's hair), a dried sea horse, to increase milk in the breasts, a red woolen sack containing bread crumbs, salt, incense and wheat from a field ripe but unspoiled by the harvester's iron, to guard against the evil eye and witchcraft.

5. Charms pertaining to animals. Examples—badger's hairs, for defense against witches, claw of a paradise bird and a monkey's paw, valid against the evil eye.

6. Roman Catholic amulets. (*a*) Authorized by

the church. Examples—the Agnus Dei and medal of St. Benedict for divers bodily ills and storms. (*b*) Unauthorized, but popularly endowed with specific virtues. Examples—the medal of the Three Magi, "witch money," the medal of St. Anthony, Hermit, for animal protection, St. Joseph's carpenter's rule for child protection, the pig of St. Anthony for luck, the medal of St. Andrea Abellino for apoplexy, the coin and the key of the Holy Spirit for infantile convulsions.

Votives. Examples—primitive Etruscan figurines of bronze, 800 B.C., ancient Roman bead incised *HER*, terra cotta heads.

In the discussion following the reading of the paper Dr. J. W. Fewkes dwelt on the amulets used by the Indians, while Dr. E. L. Morgan referred to those worn by the negroes of Washington, such as dog's teeth, etc.

Mr. George R. Stetson followed with a paper on "Some Social Fallacies."

It was universally accepted that in the millennium of perfect literacy crime would cease. But as mental culture, which by no means includes moral education, increases our sensibility and self-esteem, it also increases our ability to accumulate wealth, to acquire social position, and thus to escape the consequences of our criminal acts. The fallacies in the practise and administration of the law are made apparent in its discrepancies and defects. Decisions should be made and punishments administered without sentiment and be reformatory in character and purpose, taking into consideration the apparent motive, the circumstances of the deed and the culture of the perpetrator. A censure was also expressed against such attorneys who maintain their clients' cause *per fas et nefas*, so that many criminals are shielded from the penalty of their crimes and society is thus rendered defenceless, as is proved by statistics. Indiscriminate mercy as well as indiscriminate punishment is criminal. The power of pardon which is so frequently abused, should under our form of government be permissible only to the sovereign people in their houses of assembly. The fallacy of absolute human equality. Organic equality is nowhere found, nor does equality of opportunity produce equality in results. Hence there is also no economic equality. Absolute political, social and economic equality would not only check our progress in civilization, but also destroy what we have attained. The fallacy of excessive specialization and division of labor which results in mental and physical deterioration, in unrest and discontent. Fallacies in history and literature were illustrated by numerous examples. The fallacies of politics, statistics and legislation likewise came in for their share, concluding with a discussion of the fallacies of the missionary and civilizing enterprises.

Remarks on the paper were made by Drs. Folkmar, Casanowicz and Lamb and by Mrs. Sarah S. James.

I. M. CASANOWICZ,
Secretary

THE AMERICAN PHILOSOPHICAL SOCIETY

AT a meeting of the society on February 18, a paper entitled "The Tunnel Construction of the Hudson & Manhattan Railroad Company" was read by J. Vipond Davies, chief engineer.

The population of New York and its suburbs in New York and New Jersey has grown to a total of 6,527,000 persons, of which some 1,691,000 reside in the district in New Jersey. The traffic across the ferries of the Hudson River before the tunnels were opened to business was 125,000,000 persons per annum. No other excuse or explanation is needed for the construction of the Hudson River tunnels.

This work involved every type of tunnel construction developed by modern machinery and methods, but more particularly the so-called "shield" method, under which there are provided, (1) for supporting soil, eliminating water and making a safe place for workmen, the use of *air pressure;* (2) for supporting soil and partially removing same, for making a safe place for men, the use of a *hydraulic shield;* (3) for a permanent lining the use of *metal plates;* (4) for putting in place the lining the use of an *erector;* and (5) for waterproofing and protection the use of *cement grout*. All these methods were fully described in detail.

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

THE fifth regular meeting of the session of 1909–10 was held at the Chemists' Club on February 11.

The following papers were presented:

"Nucleic Acids," P. A. Levene.

"Determination of Sodium Chloride in Milk," Paul Poetschke.

"Some Colloid-chemical Aspects of Digestion, with Ultra-microscopic Observations," Jerome Alexander.

"The Fate of Amino Acids in the Organism," Graham Lusk.

C. M. JOYCE,
Secretary

SCIENCE

FRIDAY, MARCH 18, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE PROBLEM OF THE ASSISTANT PROFESSOR

PART I

THERE has been for some years a growing appreciation among educational institutions of the fact that their problems are not entirely individual, but present many aspects in common, and that much good may come from joint effort toward their solution. The very existence of this association sufficiently demonstrates this fact, and also amply justifies the aim of this paper. The topic offers material for a volume; the limitations of space and time for preparation have made the task of presentation chiefly one of selection and manner. The prime effort has been directed toward stating the problem of the assistant professor in concrete terms, and the method adopted may be likened to that of composite photography. Its limitations are obvious, but it has the advantage of focusing well on the main features, while enabling one to treat individual data without danger of personal identification.

A questionaire (Appendix A) was prepared and sent out to approximately 250 of the men holding the rank of assistant professor in the 22 institutions represented in this association. When replies had been received to about one half (120) of these, the writer felt forced to begin his work of compilation, in order that in the time at his disposal he might complete the collation, and have a definite result to present in this paper. Replies have continued, but they run just about the same as those here considered, and in no manner call for any essential modification of the general re-

sults. Casting out replies of those whose service was but for part time and special in kind (chiefly those holding clinical positions with nominal salaries and slight administrative connection), there remained 112 replies from 20 institutions. The initial step was to tabulate the answers to the first 17 questions, and from that tabulation the following results were compiled. The first point is that of the present age of the men replying. Table I. gives the result:

men temporarily occupying the rank on their march toward full professorship. If this point be well taken—and the writer fully believes it so to be—an entire readjustment of attitude toward the assistant professor is due. Compensation based upon the old conception will be found inadequate, and old forms of faculty organization and departmental administration will be found unduly repressive and subordinating toward amply tried and experienced men.

TABLE I

Present Age of Assistant Professors

(Two Replies Blank)

Age	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	51	58
Number	1	0	1	6	5	4	8	6	5	6	10	10	4	6	4	7	1	6	5	2	2	5	1	1	2	1	1

Group 1: 36 median age. 52 under, 48 over. Average age, 36.8 years.

Group 2: 24.6 per cent. of total.

TABLE II

Age at Appointment as Assistant Professor

(Five Replies, Age not Given)

Age	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	47
Number	2	4	1	6	12	9	10	8	10	10	6	6	7	4	2	1	1	1	1	2	1	2	1

Group 1: 31 median age. 52 under, 45 over. Average age at appointment, 31.25 years.

Group 2: 9.33 per cent. of total.

The average age is 36.8 years; 36 may also be considered the median age, as 52 of the men were under this age, while 58 were 36 years or older. Two did not state their age. Just here I wish to call attention to evidence offered by this table on an important point. The men fall into two main groups, one under 40 and one over 40. The existence of this second group (24.6 per cent. of the total) with ages running from 40 to 58, points decidedly toward the existence of a class of permanent assistant professors. This is an important matter, and must seriously modify the prevailing view that assistant professors are young

Bearing further on this point of age is Table II., which shows the age at which these men attained assistant professorship.

The average age of appointment is 31.25 years. 31 is also the median age, 52 being appointed at an earlier age than this and 55 at this or a later one. In considering some of the subsequent facts, it may be well to bear in mind that the years from 31 to 37 may properly be regarded as the cream of a man's life. "Who *is* not at twenty, *does* not at thirty, *has* not at forty, never will be, do, or have."

The average time spent in collegiate or graduate study has been 6.9 years. Seven-

teen men (15 per cent.) hold the degree of bachelor only; 28 (25 per cent.) hold none above master; while 65 (58 per cent.) hold that of doctor. Two only, whose work is in a special branch of technology, hold no degree.

63.5 per cent. received assistance in pursuing their studies, in the form of scholarships, fellowships, teaching fellowships, assistantships, student instructorships, etc. The amount varied from a single year's free tuition to a net equivalent of $2,000. No average can be struck of these or of their financial value. 36.5 per cent. received no such aid. 53.5 per cent. incurred no indebtedness for their education. 46.5 per cent. did incur such indebtedness, the average amount being $885. Of those who incurred this indebtedness, 82 per cent. have discharged it. The average sum was $800, and the average time required was 3.6 years. The remaining 18 per cent., whose debt average $1,261, have not yet succeeded in paying it off, although in some cases it has been running six, eight and even ten years. The depressing nature of such a burden need not be dwelt upon.

With the facts before him which these replies have brought, the writer is deeply impressed by the deplorable effect of the system of scholarships, etc., which do not entirely support the recipient, but act as bait and encourage him to go on with graduate study, while piling up an indebtedness which, under prevailing conditions, will ride his shoulders like a veritable old man of the sea. It is a good way to break hearts.

These histories disclose the fact that it is a pretty serious matter for a man to go even $1,000 into debt in order to enter the career of university teaching. The *manipulation* of fellowships for the purpose of "building up a strong (*i. e.*, large) graduate department" lies dangerously near the immoral; and this is doubly true when the fellowship carries with it burdensome teaching duties which make of it but a disguised, underpaid instructorship. This is making one hand wash the other in a way worthy of financial wizards. Nor can the practise of some professors of looking upon "their" fellows as a sort of intellectual valets, be too strongly condemned. A genuine fellowship will carry sufficient stipend to bear the entire burden of the recipient's cost of living on a modest scale, leave his time wholly free for his studies, and will take its sole return in deferred service to be rendered to society at large.

We next come to the question of the professorial experience of these men. The total teaching service in all ranks averages 10.3 years. Nine years is the medium period, just half having served a shorter time, and the other half a longer time than this. On the average they have served 5¼ years in the rank of assistant professor; 5 years is also about the median period, 53 per cent. having served a shorter term and 47 per cent. 5 years or more. Twelve per cent. have held the rank for ten years or more. This service is shown in Table III.

TABLE III

Years of Service as Assistant Professor

(One Reply Lacking)

Years	1	2	3	4	5	6	7	8	9	10	11	12	16	18	30
Number	11	20	17	10	14	6	7	7	6	4	1	5	1	1	1
	58 under 5 years.				53 5 years or over.										

Of the 112, 83 (74 per cent.) are married and 29 (26 per cent.) are unmarried. Table IV. shows the number and distribution of children in this group of men. No comment, beyond a reminder that the average age of these men is 36.8 years, is necessary.

The present average salary is $1,790.

TABLE IV

Number and Distribution of Children

		Total Children
Number having 0 child,	23	0
Number having 1 child,	26	26
Number having 2 children,	19	38
Number having 3 children,	12	36
Number having 4 children,	1	4
Number having 6 children,	1	6
Number having 7 children,	1	7
	83	117

117/83 = 1.4 to the family of each married.

The median salary is $1,800, 21.5 per cent. receiving just this sum, 46 per cent. receiving less and 33.5 per cent. more. The average salary for the entire 10.3 years of teaching service is $1,325. (An interesting check on this is the writer's average of $1,328.15 for his first nine years of service, reported in the *Atlantic Monthly*, May, 1905.)

Now let us focus these facts into our composite representative man. At the age of 26 or 27, after seven years of collegiate and graduate study, involving not only considerable outlay but also the important item of the foregoing of earning during this period, he is the proud possessor of his Ph.D. and is ready to enter his profession. The next five years he spends as instructor. In his thirty-second year he reaches an assistant professorship. He is now in his thirty-seventh year, having been an assistant professor for five years. His average salary for the ten years has been $1,325, which compares favorably with that of the good mechanic, but scarcely with that of men in those trained professions requiring equally arduous and expensive preparation. At thirty-seven he is married, has one child, and a salary of $1,800. These are men in twenty of the leading universities, located for the greater part in or near the larger cities!

An average salary of $1,325 for the years of a man's life between 27 and 37 is scarcely one to favor a broadening contact with life, the purchase of books, travel, association with cultivated men outside of academic ranks, etc. The most that can be said is that it may suffice for an unmarried man with no one dependent upon him. But three fourths of these men are married. Says one of these: "Previous to marriage my salary was sufficient to keep me comfortably. Since marriage, *in spite of* keeping boarders, I have fallen behind."[1]

It is therefore not at all astonishing to find that 80 per cent. have supplemented their salary with income from outside sources. No complete average can be struck, as the replies included such answers as "to a considerable extent," etc. The amount when stated (as it was in 75 cases) varied from a sum of $15 total to an independent annual income of $10,000 and averaged 28.7 per cent. of the salary. Omitting two exceptionally high cases, it was about 25 per cent.

The necessity to supplement the salary with outside income is evident from the fact that eight men report themselves running behind even on total income, while practising strictest economy. Light

[1] Compare President Eliot: "He should receive [on appointment] as assistant professor a salary which will enable him to support a wife and two or three children comfortably, but without luxuries or costly pleasures. It is well to have the appointment of assistant professor given for a fixed term of years, as, for example, five. If, at the end of his first term as assistant professor, a second appointment with the same title be given, a moderate advance of salary should accompany the second appointment. By the time the end of a second term as assistant professor is reached, the candidate for further employment in the university will be approaching forty years of age, and is ready for a full professorship" ("University Administration," p. 13). The age of appointment averages 31.25 years. Two five-year terms bring him to 41.25.

is thrown on the question, and on that of standard of living, by the following replies to the query whether the total income was sufficient, or whether they were running behind. The answers are here set down exactly in order of the tabulation. "Running even, with aid of fortunate real-estate venture on borrowed capital. Felt forced to do this." "Salary alone would not suffice to cover expenses of living with any manner of comfort." "Sufficient" (has private capital). "I keep even, but could not do it on my salary." "Can barely make both ends meet now" (in debt $1,000). "Ends compelled to meet under present method of living." "When debt incurred for study is paid, I think my income will do a little better than make both ends meet." (It would be cruel to shatter the hope. This is a young man, recently married, no children.) "Sufficient" (unmarried, supplements salary 25 per cent.). "Annual saving $500 on close living" (supplements salary 12 per cent.). "Must depend on outside sources." "Total just sufficient" (married, three children, salary $2,400). "Sufficient" (recently married). "Have had to earn outside to make income equal expenses." "Barely sufficient" (married, no children). "Running behind, $1,000 insurance recently abandoned, from inability to meet premiums" (married, two children, net indebtedness $1,094.70). "Just even with aid from other sources." "If I can keep expenses practically stationary, expect to pay debts in seven to ten years" (present indebtedness $2,053.50). "Both ends meet" (married, no children). "Have kept even, owing to remarkable freedom from sickness in family and to consistent self-sacrifice on the part of my wife." "It is against my principles to run behind, but neither can I get ahead on present salary ($1,350) or furnish necessary books and equipment to make my time count as it should." "Barely sufficient" (married, no children). "Can now make ends meet with difficulty." "Running behind a little" (present indebtedness $2,500). "Since marriage I have fallen behind." "Am making both ends meet, but it costs self-denial in buying books, etc." (married, no children, salary $1,200). "Salary would not support even my small family in —— ———. Saved a little when I wasn't teaching." And about forty more replies of the same tenor.

To complete the picture of the present financial status of these men: Seventeen men show an average net indebtedness of $1,019. The details are given in Table V.

TABLE V

Table of Net Indebtedness

	Amount	Single	Married	Children
1	$2,000.00		1	1
2	1,000.00		1	1
3	175.00		1	0
4	2,100.00		1	3
5	1,094.70		1	2
6	2,053.50		1	2
7	150.00	1		—
8	650.00		1	0
9	2,500.00		1	1
10	700.00	1		—
11	500.00		1	3
12	150.00		1	3
13	250.00	1		—
14	200.00	1		—
15[3]	600.00	1		—
16	1,500.00		1	0
17	1,700.00		1	3
	$17,323.20	5	12	

Average, $1,019.

Forty-three men show an average saving from salary of $1,765. The details are shown in Table VI. (From this table have been omitted two cases reported of saving from business ventures—one of $15,000 and one of $30,000.)

The remaining 52 report themselves as just even or make no comment. If we sub-

[3] Parents.

TABLE VI

Savings from Salary

	Amount	Single	Married	Children
1	$2,000 00	1		—
2	400.00		1	0
3	2,500.00		1	1
4	1,000.00		1	0
5	300.00	1		—
6	200.00		1	1
7	600.00	1		—
8	1,500.00		1	0
9	500.00	1		—
10	2,000.00	1		—
11	500.00		1	0
12	1,800.00	1		—
13	800.00		1	1
14	7,000.00		1	3[3]
15	800.00		1	2
16	2,500.00	1		—
17	1,200.00		1	3
18	650.00		1	1
19	1,000.00		1	1
20	1,500.00		1	0
21	2,000.00	1		—
22	3,000.00	1		—
23	7,000.00		1	0
24	5,000.00	1		—
25	3,500.00		1	2
26	300.00	1		—
27	750.00		1	0
28	4,000.00		1	0
29	6,000.00		1	7[4]
30	1,000.00		1	0
31	200.00		1	0
32	500.00		1	2
33	300.00		1	2
34	2,000.00	1		—
35	710.00		1	1
36	1,200.00	1		—
37	400.00		1	0
38	400.00	1		—
39	1,150.00	1		—
40	300.00		1	0
41	1,250.00		1	2
42	700.00	1		—
43	5,500.00		1	2[5]
Total	$75,910.00	16	27	

Average, $1,765.

tract the reported total deficit from the reported total saving from salary and divide by 112, the number of replies received, the average net saving per man for 10.3 years teaching service is $559.

Twenty-five carry no life insurance, 86 carry an average of $4,831. With a grim humor, one man who carries $6,000 insurance comments: "I seem to be worth more dead than alive." Nine report accident insurance in addition, an average of $4,445.

The table of savings from salary is scarcely less significant than that of deficits. Surely no demonstration is needed that the present scale of salaries in this rank is only sufficient to provide a modest living for a single man. Remember that the average salary during the ten years of service has been but $1,325, and the present salary for men of 37 years of age averages $1,800. The married men must supplement their income as best they may to make both ends meet—the salaries are insufficient to do it, on the scale of living demanded of them by their position and training.

Such divided efforts can not fail to affect not merely their further development, but their continuing efficiency. This problem of salaries is grave, and the possibility of readjustment worthy of most serious consideration by the administrative authorities. Particular attention may be called to the need for special consideration of those men in this rank who have passed their fortieth year—the possibly existing class of permanent assistant professors.

The rapid increase in the cost of living, in the past twenty years, has made the situation acute; for there has been no general increase of salaries commensurate with this, and as a consequence these men find themselves driven to a lower and lower standard of living. This is a grave menace to the efficiency of the institutions both present and future, for it must not be forgotten that the higher ranks must be recruited from time to time from men whose development has necessarily been limited by the conditions surrounding this rank.

Stanford University Guido H. Marx

(*To be continued*)

[3] Not a college graduate.

[4] Salary, $4,000

[5] Salary, $2,250. Supplemental, 30 per cent.

THE PALEONTOLOGIC CORRELATION THROUGH THE BACHE FUND

IN 1908 the National Academy of Sciences appointed a committee on comparative research in paleontological correlation with power to add foreign and American associates to their number. The committee was divided into vertebrate and invertebrate sections. The vertebrate section organized with the following members: Professor H. F. Osborn, of Columbia University and the U. S. Geological Survey, chairman; Professors Scott, of Princeton University; Dollo, of Brussels University; Deperét, of Lyons University; Fraas, of Stuttgart University; Koken, of Tübingen University; von Huene, of Tübingen University; Williston, of the University of Chicago. Associated for special subjects: Professor J. C. Merriam, of the University of California; Dr. R. Broom, of Victoria College, Stellenbosch; Dr. Santiago Roth, of La Plata, Argentina; Dr. W. D. Matthew, of the American Museum of Natural History, secretary.

The trustees of the Bache Fund of the National Academy of Sciences through Professor Charles S. Minot, secretary, appropriated $500 for the work of the committee during the year 1909, and recently made a second appropriation of $500 for the year 1910. The fund is used partly to defray the expenses of correspondence, chiefly to direct investigation and secure special reports from various members of the committee and others.

The council of the New York Academy of Sciences in 1909 generously offered to cooperate with this research by the publication of the series of bulletins reporting progress. These bulletins are partly published and illustrated with the aid of the Bache Fund. They are as follows: Bulletin No. 1, "Plan and Scope," by Henry Fairfield Osborn and W. D. Matthew; Bulletin No. 2, "Fossil Vertebrates of Belgium," by Louis Dollo, translated by W. D. Matthew; Bulletin No. 3, "Patagonia and the Pampean Formation," review of correlation of Santiago Roth, with lists of characteristic species and provisional systematic references, by W. D. Matthew.

The chairman of the committee has devoted his entire time (1909) to the preparation of a book entitled "The Age of Mammals," in which the results of his researches upon the correlation of the Tertiary and Quaternary periods, and the development and succession of mammalian faunas during the Cænozoic are set forth more fully and completely than in previous publications, and with as broad and popular a treatment as the subject permits.

The secretary has prepared a series of faunal lists of the Tertiary mammals of North America, on the lines laid out in the preliminary bulletin entitled "Plan and Scope" (p. 45). The object of these elaborate and extended lists is to enable correlators to "get behind the record," to enable them to critically consider each faunal list, to estimate the weight of evidence afforded by each species listed. In such an estimate the exact level and locality, the authority and date of description, the perfection or imperfection of the types, their location (to facilitate reexamination) are always essential factors; and such other data as may seem of value are given in the annotations. Mere lists of species without such data behind them are apt to be confusing and misleading. The results attained in correlations based upon bare lists of species are almost always a summary or average of discordant data. The best that can be hoped for will be that it will be a fair average; and where a preconceived bias exists on the part of the workers in a particular region, it will often be so manifestly incorrect that the results are generally rejected, and the entire subject of correlation discredited by them. Discordance in the evidence we take to be a proof that there is somewhere an error. The publication of these lists with complete data as to each species recorded, and with sections, lists of principal publications and annotation of various kinds, will assist, it is hoped, in locating and eliminating such errors.

Dr. Matthew has also in preparation lists of all the American vertebrate faunæ, with such data as could be readily obtained. These are now completed down to the year 1900. They will be submitted to the several authorities in

charge of different periods for the addition or completion of data, and annotations and geological sections as outlined in the preliminary bulletins. With similar data from foreign horizons these will form a broader and more permanent basis for exact correlation than has hitherto been available.

The general interest that has recently been aroused among students of fossil vertebrata is attested by the appearance of a number of important papers dealing with the more exact correlation of formations in which fossil vertebrates are found. Important additions to the evidence as to the position of the Mesozoic and Cænozoic formations of the Argentine by Ameghino, Roth, Scott, Ortmann, Hatcher and Sinclair have in recent years advanced this difficult problem a long way toward solution. The recent work of J. C. Merriam in California, Oregon and Nevada has been of the highest quality and great importance in correlation of the Pacific slope and other sections of this continent. Von Huene's investigations in the European Triassic, Broom's studies upon the South African Permian and Mesozoic, have already gone far toward clearing up these great problems in correlation. These are cited but as examples of the spirit of thorough, exact and progressive method in which many investigators are carrying on the work, each in his special province.

Correlation of more or less importance is contained in the series of papers published within the last year by Osborn, Matthew, Douglass, von Huene, Knowlton and Broom.

During the coming year the secretary of the committee will devote himself to the preparation of correlation lists for the North American Tertiary and for the North American pre-Tertiary. Data will be prepared for the North American Cretaceous and Cretaceous-Eocene contact by Osborn and Brown. The committee has promised also a number of American and foreign pre-Tertiary faunal correlations by members and associates.

Inquiries should be addressed to W. D. Matthew, American Museum of Natural History, New York.

THE INTERNATIONAL AMERICAN CONGRESS OF MEDICINE AND HYGIENE

The International American Congress of Medicine and Hygiene of 1910 in commemoration of the first centenary of the May revolution of 1810, under the patronage of the president of the Argentine Republic, will be held May 25, in Buenos Aires, Argentine Republic.

In order to facilitate the contribution of papers and exhibits from the United States, there has been appointed by the president of the congress, Dr. Eliseo Cantôn, and the Minister of the Argentine Republic at Washington, a committee of propaganda, of which Dr. Charles H. Frazier (Philadelphia, Pa.) is chairman and Dr. Alfred Reginald Allen (Philadelphia, Pa.) is secretary.

The congress has been divided into nine sections, each section being represented in the United States by its chairman in this committee of propaganda as follows:

Section 1—Biological and Fundamental Matters, Dr. W. H. Howell, chairman, Baltimore, Md.

Section 2—Medicine and its Clinics, Dr. George Dock, chairman, New Orleans, La.

Section 3—Surgery and its Clinics, Dr. John M. T. Finney, chairman, Baltimore, Md.

Section 4—Public Hygiene, Dr. Alexander C. Abbott, chairman, Philadelphia, Pa.

Section 5—Pharmacy and Chemistry, Dr. David L. Edsall, chairman, Philadelphia, Pa.

Section 6—Sanitary Technology, Dr. W. P. Mason, chairman, Troy, N. Y.

Section 7—Veterinary Police, Dr. Samuel H. Gilliland, chairman, Marietta, Pa.

Section 8—Dental Pathology, Dr. George V. I. Brown, chairman, Milwaukee, Wis.

Section 9—Exhibition of Hygiene, Dr. Alexander C. Abbott, chairman, Philadelphia, Pa.

It will not be necessary for one contributing a paper or exhibit to the congress to be present in person. Arrangements will be made to have contributions suitably presented in the absence of the author. The official languages of the congress will be Spanish and English. Members of the following professions are eligible to present papers or exhibits: Medicine, pharmacy, chemistry, dentistry, veterinary medicine, engineering and architecture.

Papers may be sent direct to the chairman of the particular section for which they are intended, or to Dr. Alfred Reginald Allen, Secretary, 111 South 21st Street, Philadelphia, Pa.

THE ELIZABETH THOMPSON SCIENCE FUND

THE thirty-fifth meeting of the board of trustees was held in Boston, Mass., on February 2, 1910.

The following officers were elected:

President—Edward C. Pickering.
Treasurer—Charles S. Rackemann.
Secretary—Charles S. Minot.

The secretary stated that during the past year no reports had been received from the following holders of grants: 22, 27, E. Hartwig; 107, M. W. Travers; 117, E. Salkowski and C. Neuberg; 123, E. C. Jeffrey; 131, F. W. Thyng; 134, C. L. Alsberg.

The reports received from the following holders of grants were accepted as reports of progress: 98, J. Weinzirl; 109, A. Nicolas; 111, R. Hürthle; 119, J. P. McMurrich; 121, E. Debierne; 124, P. Bachmetjew; 133, J. F. Shepard; 136, H. Z. Kip; 137, C. H. Eigenmann; 138, Mme. P. Šafarik; 140, K. Guthe; 141, J. P. Patterson; 142, W. J. Hale; 144, G. A. Hulett; 146, M. Nussbaum; 147, J. Müller; 148, C. C. Nutting; 149, P. A. Guye; 152, W. D. Hoyt; 154, J. P. Munson.

It was voted to close the accounts of the following grants: 135, A. Negri; 139, J. Koenigsberger; 145, J. de Kowalski; 151, O. von Fürth; 153, W. Doberck, and to close upon receipt of publications the account of grant 143, awarded to Professor R. W. Wood.

The secretary stated that a fifth publication had been received from Professor E. Wiedemann, acknowledging the aid obtained through grant 127.

The trustees greatly regretted to be obliged to decline several applications which were highly deserving of aid.

It was voted to make the following new grants:

155. $300 to Dr. H. P. Hollnagel, Berlin, Germany, for a redetermination of the longer wave-lengths in the extreme infra-red portion of the spectrum, by an interferometer method.

156. $100 to Professor R. Thaxter, Cambridge, Mass., for further studies on the Laboulbeniaceæ.

157. $100 to Dr. L. Mercier, Nancy, France, to study the bacteria living symbiotically within various invertebrates.

158. $50 to Professor H. V. Neal, Galesburg, Ill., for a study of nerve histogenesis in *Squalus acanthias*.

159. $100 to Dr. B. M. Davis, Cambridge, Mass., for cytological and genetical studies on native species of Oenothera.

160. $50 to Dr. L. J. Henderson, Boston, Mass., for a research upon the use as indicators of aromatic nitro compounds which contain phenolic hydroxyl groups, or amino groups, or carboxyl groups.

161. $100 to Professor O. von Fürth, Vienna, Austria, for further studies on internal secretion.

CHARLES S. MINOT,
Secretary

SCIENTIFIC NOTES AND NEWS

INVITATIONS for the centennial celebration of the University of Berlin, to be held in October of this year, have been sent to the visiting professors who have represented Harvard University and Columbia University at the University of Berlin. These include Professors Theodore W. Richards and W. M. Davis, of Harvard University.

THE official delegation from the Geological Society of America to the eleventh International Geological Congress to be held at Stockholm, Sweden, in August of this year has been constituted as follows: Arnold Hague, Sc.D., U. S. Geological Survey, president of the Geological Society of America; Charles R. Van Hise, LL.D., University of Wisconsin; James F. Kemp, professor of geology, Columbia University; Frank D. Adams, D.Sc., dean of the faculty of applied science, McGill University, and Edmund Otis Hovey, Ph.D., curator of geology and invertebrate paleontology, American Museum of Natural History.

PROFESSOR HUGH D. REED has been appointed delegate from Cornell University to

the eighth International Zoological Congress at Gratz.

Sir Victor Horsley, F.R.S., has been elected a foreign associate of the French Academy of Medicine.

The faculty of the Agricultural College of the University of Minnesota has given a dinner in honor of Dr. A. F. Woods, the new dean of the college.

Professor W. B. Gregory, of Tulane University, has been elected president of the Louisiana Engineering Society.

The British secretary of state for the colonies has appointed Mr. W. D. Ellis, of the Colonial Office, to be a member of the advisory committee on medical and sanitary questions connected with the British colonies and protectorates in Tropical Africa.

At the Lister Institute of Preventive Medicine, London, Mr. H. R. Dean and Dr. G. H. Macalister have been appointed assistant bacteriologists and Dr. H. McLane, senior assistant in the biochemical department.

Dr. W. F. Hume has been appointed director of the Geological Survey of Egypt.

Dr. Walter Knoche, of Berlin, has been appointed director of the newly established Meteorological and Geophysical Institute of Chili, and at the same time professor of meteorology in the University of Santiago.

Professor James H. Tufts, of the University of Chicago, is giving at the Johns Hopkins University a course of ten lectures on modern problems of metaphysics and the theory of knowledge.

M. Emil Boutroux, professor of philosophy at the Sorbonne, Paris, is now lecturing at Harvard University on the Hyde foundation.

Dr. H. E. Crampton, professor of zoology at Barnard College, Columbia University, and curator of invertebrate zoology at the American Museum of Natural History, lectured at Vassar College, on March 9, on "Exploring the Islands of the South Seas."

Professor S. A. Mitchell, of Columbia University, on March 4 and 11, delivered lectures in Philadelphia on "Halley's Comet."

President Charles R. Van Hise, of the University of Wisconsin, is to deliver one of the principal addresses on the conservation of natural resources at the first Minnesota Conservation and Agricultural Development Congress, in St. Paul, Minn., March 16 to 19.

At the annual dinner of the Harvard Teachers' Association, on March 12, addresses on "The American College" were made by Professor J. McKeen Cattell, of Columbia University, and President A. Ross Hill, of the University of Missouri.

Sir J. J. Thomson will give the evening discourse at the Royal Institution on March 18, on the dynamics of a golf ball.

We learn from the *Geographical Journal* that a monument to the French navigator, Bougainville, has been inaugurated, with appropriate formalities, at Papeete, on the island of Tahiti, which island he visited a few months after its discovery by the English navigator Wallis. The proposal for the erection of the monument emanated from a French colonial official, a member of the Paris Geographical Society, by which body it was taken up with enthusiasm. The bust erected at Papeete was in part a copy of that in the possession of the Paris Society, but portraits preserved in the navigator's family were also utilized by the sculptor. The scheme received the support of the French government as well as of the municipality of Papeete, and the ceremony of inauguration was opened by a speech by M. François, governor of French Oceania. Two French and two British warships were present on the occasion.

Dr. J. A. Bergström, professor of pedagogy at Stanford University, previously professor of pedagogy and director of the psychological laboratory at the University of Indiana, died on February 28, at the age of forty-two years.

Dr. Charles F. Wheeler, botanical expert in the Bureau of Plant Industry, U. S. Department of Agriculture, formerly assistant botanist in the Michigan Agricultural College, died March 5, 1910, at the age of sixty-eight years.

THE death is announced, at the age of thirty-three years, of Mr. J. F. Ferry, known as an ornithologist, who had been connected with the Field Museum of Natural History and the U. S. Biological Survey.

MR. EDWARD SAUNDERS, F.R.S., eminent for his contributions to systematic entomology, died on February 6, in his sixty-second year.

M. PHILLIPPE THOMAS, known for his geological work in northern Africa, has died at the age of sixty-seven years.

DR. ARTHUR BORDIER, professor of natural history at the medical school of Grenoble, has died at the age of sixty-nine years.

THE scientific societies and universities of Australia are, as we have already noted, taking steps to arrange that the British Association for the Advancement of Science shall visit Australia in 1913 or 1914. An influential deputation, at the head of which was Sir John Madden, chancellor of Melbourne University, waited on the federal prime minister recently with a request for a federal guarantee up to the sum of £10,000. The prime minister is said to have expressed his personal approval.

A BILL has been introduced in the Ohio senate to appropriate $1,000 to organize and equip a Pasteur Institute for the treatment of hydrophobia at the Ohio State University, Columbus, and to appropriate $1,000 annually for maintenance.

IT is reported that Mr. Andrew Carnegie has offered to give a prize of $25,000 to the first student of the Carnegie School of Technology, of Pittsburgh, who will construct an aeroplane satisfying certain conditions.

THE trustees of Mr. Otto Beit's gift of £215,000 for the foundation and endowment of medical research scholarships met on February 23, and awarded the first set of the fellowships. *Nature* states that seventy applications were received—fifty-eight from England, three from Scotland, one from Ireland, one from Wales and seven from abroad. The following fellows were elected, and were authorized to proceed with the researches mentioned after their names: Mr. G. H. Drew, the zoological distribution of cancer and a systematic study of an experimental character on the mode of origin of neoplasms (tumors); Dr. F. W. Edridge-Green, various problems connected with vision and color-vision, especially in relation to the correct reading of signals on land and sea; Mr. E. Hindle, the morphology and treatment of protozoic blood parasites, especially *Sporochœta duttoni* and trypanosomiasis (sleeping sickness); Dr. T. Lewis, the mechanism of irregularities of the heart; Dr. G. C. McKay Mathison, (*a*) the nervous control of respiration and (*b*) the effect on respiration of changes in the chemical composition of the blood; (*c*) the mechanism of biliary secretion and its general effect in digestive processes; Dr. Otto May, clinical and experimental research on the lesions of peripheral nerves; Mr. E. Mellanby, the significance of the large excretion of creatin in cancer of the liver and its diminished excretion in cirrhosis of the liver, etc.; Dr. F. P. F. Ransom, the mode of action of caffeine, theobromine and allied substances on the muscular and nervous systems; Dr. S. Russ, the association of radioactivity with cancer; Dr. Ida Smedley, the processes involved in the formation of fat in the organism. The next election of fellows will be held about December 15 next. All inquiries should be addressed to the honorary secretary, Beit Memorial Fellowships for Medical Research, 35 Clarges Street, Piccadilly, London, W.

THE second session of the Biological Station of the University of Michigan will begin July 5 and continue for eight weeks, closing August 26, 1910. The station is located on the shores of Douglas Lake, Cheboygan County, in northern Michigan, and is particularly well located for field and laboratory courses in zoology and botany. The work of the station is under the supervision of Professor Jacob Reighard, head of the department of zoology in the University of Michigan, as director. The active staff will consist of Dr. A. S. Pearse, instructor in zoology in the University of Michigan and assistant director of the Biological Station; Assistant Professor Raymond J. Pool, of the

department of botany of the University of Nebraska and director of the Nebraska State Botanical Survey; Mr. Norman H. Stewart and Miss Lucie Harmon, assistants in zoology in the University of Michigan; Mr. F. A. Loew, professor of science in Central College, Indiana, will act as assistant in botany. The courses of instruction will include: the natural history of invertebrate animals, field studies in vertebrate zoology, zoology for teachers, special work in research in zoology, first course in field and forest botany, mycology, systematic botany of seed plants, advanced work in research in botany.

A report on the feldspar deposits of the United States, by E. S. Bastin, has just been published by the United States Geological Survey as its Bulletin 420. The feldspars are among the most widely distributed minerals and are constituents of nearly all rocks. The decomposition of feldspar has yielded a large part of the clay of the soil; also the mineral kaolin, an essential material for making fine pottery. Most of the commercially valuable feldspar now mined is obtained from rocks known as pegmatites, the commonest variety of which is essentially a very coarse granite. Feldspar is mined and ground for use mainly by potters, but a portion of the product is used in the manufacture of emery and other abrasive wheels, to bind the abrading particles together, and small quantities are employed in making opalescent glass, scouring soaps, roofing material and poultry grit. Feldspars that are rich in potash are now the subject of experiments made to determine their value as fertilizers. The principal feldspar quarries in the United States are in New England and the middle Atlantic states, and the annual value of the product is now about half a million dollars. Mr. Bastin discusses the chemical and physical character of the feldspars, their geologic occurrence and origin, and the methods of mining and milling, and describes in detail the deposits worked at the numerous quarries.

The annual report for the year 1909 of the Philosophical Institute of Canterbury, New Zealand, presented to the annual meeting held last December, is abstracted in *Nature*, which states that during the year the publication of the results of the expedition to the sub-Antarctic islands of New Zealand was steadily proceeded with under the editorship of Dr. C. Chilton. The reports upon the work will consist of two quarto volumes of about 400 pages each, and will be illustrated with numerous plates (some colored), photographs and text-figures; they will be accompanied by a large colored map of the Antarctic and sub-Antarctic regions, showing the ocean depths as ascertained by recent expeditions. Work in botany has been carried on by Dr. Cockayne during the past two years. Although a great deal has been done in the way of establishing sanctuaries and national parks in order that the native fauna may be preserved for all time, the importance of placing on record their present ecological condition can hardly be overestimated. It is hoped that at some early date the government may see its way to authorize Dr. Cockayne to proceed further with the botanical survey of the Dominion. Largely owing to the representations of the institute, combined with those of the Otago Institute, the position of the memorial to the late Sir James Hector has been made satisfactory. Owing to the action of the government in granting a generous subsidy, ample funds will be at the disposal of the committee for establishing a memorial that will be worthy of Sir James Hector's long and distinguished service to the cause of science in New Zealand. Observations in connection with the Arthur's Pass Tunnel were continued throughout the year. Temperature readings have been taken every ten chains and specimens collected. Early last year a committee was formed for the purpose of investigating systematically the artesian system of Christchurch and the neighborhood. The committee has held several meetings, and has taken preliminary steps for ascertaining the extent, depth and geological relations of the water-bearing strata, and for the examination of physical, chemical and biological properties of the water obtained from them. Two papers by Dr. Farr and Mr. D. C. H. Florance, on the radium emanation con-

tained in the artesian water and on the effect of the water as it comes direct from the well on trout and other fish, have already been laid before the institute. A committee was appointed to consider the Animals' Protection Act, and to suggest amendments with the view of giving more effective protection to the native fauna of the Dominion. A conference was held with a similar committee appointed by the Canterbury Acclimatization Society, and a number of recommendations were made which received the approval of the council. It is intended to submit the proposals to other institutes for their consideration, and if they meet with approval to bring the matter under the notice of members of parliament and of the minister for internal affairs. It is hoped later to send a party to the Chatham Islands for purposes of scientific investigation.

IN reclaiming the Great Valley of California the removal and control of mining débris in the rivers play a very important part. It is estimated that the bed of Yuba River alone contains three hundred million cubic yards of this débris. By these deposits the low-water stage of this stream was raised 15 feet at Marysville between 1849 and 1881, and the stream bed near this place is now 13 feet above the level of the surrounding farm land, so that it has been necessary to build large dikes or levees along the river. For four years the United States Geological Survey has been studying this débris problem, as it has been called, and in connection with the study a hydraulic laboratory was built at the University of California, Berkeley, Cal., for the experimental investigation of the laws of transportation of sand and gravel by water. This investigation has outgrown the narrow limits of the laboratory, and it is proposed to continue this work on a much larger scale in connection with one of the projects of the United States Reclamation Service. In a preliminary report now in preparation the apparatus and methods employed will be described and the results obtained will be discussed in detail. The results will be expressed by formulas and represented graphically by curves. Relations connecting the discharge, slope and load will be given for eight sizes of sand and gravel and for artificial and natural mixtures. The experiments include stream transportation, in which the stream bed is sand or gravel—a self-made bed—and flume transportation, in which the bed is wood or metal, as in sluicing. The accuracy and the applicability of the results to practical problems will be discussed and the data that have only an indirect bearing on the débris problem will be presented in three appendixes. If means are provided for the use of the larger apparatus and the much larger water supply that will be available in connection with the reclamation project some of the data thus far obtained will be tested and the relations connecting the factors of transportation will be extended so as to make them more directly applicable to problems of stream control and economic sluicing.

UNIVERSITY AND EDUCATIONAL NEWS

COLUMBIA UNIVERSITY has received an anonymous gift of $350,000 for the erection of a building for the faculty of philosophy, which has charge of the graduate work in philosophy and languages. The university has also received anonymously $15,000 for work in agricultural education.

A ZOOLOGICAL laboratory is to be erected at the University of Pennsylvania, at a cost of about $250,000. In making the announcement on university day, Provost Harrison stated that it would be "the most complete biological laboratory yet erected."

BY the will of Mrs. Mary A. Richardson, Tufts College receives $40,000 for fellowships.

AT Columbia University William B. Fite, Ph.B. and Ph.D. (Cornell), professor of mathematics at Cornell University, and H. E. Hawks, A.B. and Ph.D. (Yale), assistant professor of mathematics at Yale University, have been appointed professors of mathematics. George B. Wendell, B.S. (Massachusetts Institute), Ph.D. (Leipzig), professor in the Stevens Institute, has been appointed professor of physics. Charles H. Burnside, of the University of Wisconsin, has been ap-

pointed assistant professor of mathematics. Dr. Charles Lane Poor, professor of astronomy in Columbia University, has been transferred to a chair of celestial mechanics.

At Cambridge University Dr. E. W. Hobson, F.R.S., fellow at Christ's College, has been elected Sadlerian professor of pure mathematics.

DISCUSSION AND CORRESPONDENCE

THE RETROSPECTIVE ANTICIPATIONS OF THE CARNEGIE FOUNDATION

To the Editor of Science: The fourth annual report of the president of the Carnegie Foundation, the most important part of which is published in your issue of February 25, is marked by one feature which seems scarcely less sinister than the breach of faith on the part of the foundation which was discussed in my remarks printed in the same issue.

The rules for the granting of service pensions by the foundation, as promulgated in the first annual report, and as explained in the statements of the president at that time and subsequently, contained no word indicating that these pensions were to be regarded as disability pensions. In the federal charter of the corporation, moreover, as well as in many other expressions of the purpose of the foundation,[1] service, old age and disability pensions have always been specifically distinguished. The first annual report contains, further, the following statement (page 37):

> To better the profession of the teacher, and to attract into it increasing numbers of strong men, it is necessary that the retiring allowances should come as a matter of right, not as a charity. No ambitious and independent professor wishes to find himself in the position of accepting a charity or a favor, and the retiring allowance system, simply as a charity, has little to commend it. It would unquestionably relieve here and there distress of a most pathetic sort, but, like all other ill-considered charity, it would work harm in other directions. It is essential, in the opinion of the trustees, that the funds shall be so administered as to appeal to the professor in American and Canadian colleges from the standpoint of a right, not from tnat of charity, to the end that a teacher shall receive his retiring allowance on exactly the same basis as that upon which he receives his active salary, as a part of his academic compensation.

[1] *Cf.* especially First Report, p. 14.

These early announcements of the foundation have been generally construed by the profession, in their natural sense, as implying that both service and old-age pensions were to be regarded as a form of deferred salary, earned by the previous service of the recipients, and not presupposing on the part of the recipients either destitution or disability. Acting upon this understanding, some twenty-eight gentlemen,[2] who were not physically incapacitated, and who apparently made no pretension to being either "pathetic cases" or "geniuses," accepted service pensions.

The trustees of the foundation have now determined to abolish all service pensions as such, and to substitute therefor a system of disability pensions. The new report of President Pritchett accordingly reads back into the past intentions of the foundation its present purpose, and makes it appear that the service pensions were, from the start, designed essentially for disabled teachers. The new report contains the following passage, which should be compared with that just quoted from the first report. The original Rule II. was adopted to make

> provision for teachers, who, after long service, have become broken in health, or who, by physical infirmity, such as loss of hearing, are incapacitated for their calling. Among the most pathetic cases in the profession of the teacher, and those most embarrassing to the colleges, have been ones in which teachers have, often after faithful service, broken in health and found themselves with approaching age practically helpless.

The same rule was in a minor degree also intended to provide for "the rare cases which now and then arise when a man of real genius as a scholar might prefer to accept a smaller pension and devote himself exclusively to productive work in science or literature." The president of the foundation quotes verbatim the original service pension rule (which says nothing whatever about disability) and immediately adds the surprising comment, "the second rule thus became a complex one, covering service and disability." (It may be noted

[2] Fourth Annual Report, p. 72.

that the word "disability" was already to be found in ordinary English dictionaries in the year 1906.) "It was believed," says President Pritchett, "that the number of teachers who would avail themselves of retirement under such conditions would be confined almost exclusively to those who were physically impaired."

In accordance with this retroactive construction of the original rules and announcements—a construction nowhere sanctioned by anything in the language of them—the president of the foundation reflects severely upon the twenty-eight persons who, without disability, accepted service pensions.

> The expectation that this rule would be taken advantage of almost wholly on the ground of disabilities has proved to be ill-founded. . . . The correspondence . . . indicates that a number of teachers have persuaded themselves that they are specially intended for research. Some of these have a small income, which, even with the minimum pension, promises a safe, if not ample, support. Others are "tired of teaching." It seems that this rule offers too large a temptation to certain qualities of universal human nature.

From this and other recent statements it appears not only that no one is assured of actually receiving the retiring allowances which the foundation by its rules at any given time announces it will grant, but also that those who are granted pensions upon terms which seem to be clearly understood, and to be sanctioned by the foundation at the time, may thereafter be subject to censure from the president of the foundation for having taken the pensions which were offered them. This is not a situation wholly calculated to increase the attractiveness of the foundation's pension system, or "to dignify and strengthen the calling of the teacher."[8] It certainly affords conclusive evidence, which should be pondered by professors and governing boards in "accepted institutions," that the apparently plain language of the foundation's rules gives no clue whatever as to what the officials of the foundation may subsequently announce that they have previously been anticipating.

[8] First Report, p. 31.

The recent report also mentions, among the chief reasons for the abolition of the service pension, "the tendency of the teacher assured of a retiring allowance to become ultra-critical toward the administration" of his university. This seems to mean, if it means anything, either that an important proportion of the members of the profession are kept in order only through their fear of losing their positions, and that, if assured of an independent competency, they would forthwith behave in an unreasonable manner; or else it means that, whether the criticism that might proceed from professors were reasonable or not, they should, in any case, be kept silent and subservient by a mild form of terrorism. I can not think that the publication, by a person holding the position of the president of the Carnegie Foundation, of such views as this concerning the average character and self-respect and the proper status of the members of our profession, is likely to improve the public standing of that profession. There seems to be grave reason to conclude that it is time for the rank and file of the teaching body to demand that the management of the Carnegie Foundation shall be altered in whatever manner is necessary in order to protect them against the sort of deception and the sort of indignity to which they have been subjected in the recent administration of this potentially beneficent institution.

ARTHUR O. LOVEJOY

COLUMBIA, MO.

THE NORWOOD "METEORITE" A FRAUD.[1] HOW METEORITIC EVIDENCE MAY BE MANUFACTURED

TO THE EDITOR OF SCIENCE: As a result of continued investigation of the supposed Norwood "meteorite," I am now able to state definitely that the whole thing is a cunningly devised fraud. In order that investigators may be on their guard against similar deceptions, it seems to me desirable to put the facts on record. I will first state the apparent facts.

[1] See SCIENCE, N. S., Vol. XXXI., No. 787, January 28, 1910, pp. 143 and 156.

Mr. Herbert S. Winslow, who is a trained hunter with excellent powers of observation, was standing near Walpole Street, a little beyond Chapel Street, in Norwood, and had an unobstructed view of the western sky in a quiet country neighborhood. He was looking upward and saw a brilliant object appear in the west at an altitude of about 60°. It fell slowly at first, then quite rapidly, disappearing behind some distant pine trees in a direction a trifle north of west in about 7 seconds. There was an increase in apparent size in the ratio of not over 3 to 1. The brightness varied in a somewhat larger ratio. The object was pear-shaped, sharply pointed at the advancing (lower) extremity, but rounded above, about twice as long as broad and as large as the moon, brightest at the margins, and of an orange-red color. It moved with a wavy, serpentine motion, and gave off numerous white sparklets on either side, about as bright as Polaris. These sparklets faded out before traversing a distance greater than the length of the main body. The object fell in the direction of the Nickerson farm, distant 0.8 miles, and was different from an ordinary shooting star. Its considerable angular dimensions imply a flaming mantle of incandescent vapor. The time was 6:42 P.M., October 7, 1909. Other observers in Norwood confirmed enough of these statements to make the fact beyond dispute; but, singularly, I could find no witnesses from surrounding towns after assiduous search.

The motion having been very slow at first, but rapid at the end, the appearance was not inconsistent with the supposition that the object might have been advancing at first nearly end-on, and that the path then curved rapidly into a vertical direction—a motion of which there was good evidence in the fall of a 33-pound meteorite at Krähenberg in Bavaria, May 25, 1869, which is said to have "entered the ground to a depth of from three to four feet, making a perfectly vertical hole"; but from observations at neighboring places, "the inclination of the path of the meteor to the horizon is computed to have been 32°."[3]

[3] Dr. Flight, "History of Meteorites," p. 5.

The serpentine motion is sometimes witnessed in shooting stars. I have never seen *white* sparklets from an *orange*-colored meteor, although I have witnessed the fading of exploded fragments of a brilliant white meteor through yellow and orange to red. The fall of a bolide without noteworthy sound is exceptional, but not unprecedented. Ordinarily, the noises are very loud, often "terrific."

The following coincidences are to be noted:

1. An object not unlike a fire-ball was seen to fall in a given direction.

2. At a point in this direction, and within a few hours after the occurrence, a farm hand who knew nothing about the fire-ball, found that a set of bars had been unaccountably broken at some time during the previous night.

3. A peculiar, large and heavy stone—an ophitic andesite porphyry, entirely different from the glacial boulders of the vicinity—a stone quite competent to smash the bars if fired through them with the velocity of a cannon shot, but not able to do the damage if it had been merely dropped from a height of a few feet, was found directly under the break, according to the statement of Mr. W. P. Nickerson, the owner of the farm.

4. The stone had apparently penetrated deeply into the soft sand, as if it had dropped with great velocity.

5. On being pried out of the sand, the lower and better protected end of the stone, which would naturally be the advancing end, was found to be still hot (statement of the farmer, confirmed by workmen, and by an unprejudiced neighbor).

6. The sand around the stone was dry, whereas the surrounding earth was moist, on authority of Mr. Nickerson.

The peculiar composition of the stone, while distinguishing it clearly from local boulders, equally differentiated it from all known aerolites, and was a distinct difficulty in the way of accepting the stone as a meteorite. I at first thought that this difficulty might be met, the absence of an external vitrified coat being attributable to a description of the groundmass of which the sparks might have been an

evidence, and was more impressed by the fact that the disturbance of the ground at the point of impact was not as great as I should have anticipated. So far, the evidence, though puzzling, seemed too strong to be summarily rejected.

A diligent search of the surroundings and an excavation which I made at the supposed point of impact to a depth below all previous disturbance, had failed to reveal any other stone of a meteoritic nature. The composition of the specimen was quite different from that of neighboring dike rocks, and was absolutely unlike the vast majority of granite, diorite, and dark, banded, or concretionary felsitic boulders of the local glacial drift. The surfacing was such as a water-worn boulder of its composition might receive, if it had lain for a long time in a peat bog, where the fine-grained ground-mass could be disintegrated, leaving the phenocrysts protruding. The actual site, however, was not of this description, but was on the sloping border of a dissected sand-plain, some twenty to thirty feet above the neighboring valley.

Now for the real facts: It appears that the proprietor of a cheap vaudeville show in Boston, purchased the "meteorite" from a Vermont man. It was said to have "fallen" in New Hampshire. The new owner seems to have thought it necessary to work the thing up and give it "local color." Accordingly, the stone (previously heated?) was taken to Norwood in an automobile, by night, and deposited on the farm of Mr. Nickerson, who was in the secret. I have talked with one of the employees of the dime-museum, who confessed that he was the man who broke the bars in the night. The next morning, Mr. Nickerson made an errand for one of the farm hands to the pasture (to hunt up a stray cow, or some such thing), the errand being so arranged that the man could not help finding the broken bars. On receiving the report of the occurrence, the farmer was apparently the most surprised man in town. Close questioning could not trip him.

I have been unable to ascertain how or when the stone was heated, nor do I know the secret of the fire-ball; but I suggest that the luminous appearance may have been produced in the following way: A large inverted rocket of suitable make, suspended from a (captive?) balloon, may have been sent up to a height of something over a mile, being provided with a time-fuse which burst the balloon and started the rocket downward at the same time. The farmer, in giving his version said: "My first idea was that the stone had been dropped from a balloon," showing that his mind was running on balloons. A vague story, insufficiently corroborated, has reached me, which implies that a similar bright object was seen in the same direction about four hours later on the same night, which possibly signifies that the rocket scheme was worked twice in order to make sure that the light should be seen by somebody not in the business, and whose testimony could not be impeached.

A few words in regard to the petrographical examination of the stone may be in order, since they may lead to an identification of the locality of an interesting specimen. It has every appearance of having been originally derived from an ancient terrestrial igneous rock which has been metamorphosed to some extent by hot mineral waters under heavy pressure, but shows little evidence of the action of mountain-building forces. Microscopic examination of a thin section shows that the material consists largely of labradorite feldspar arranged in ophitic structure. The clear greenish-white crystals appear entirely transparent in section, except for some trifling inclusions, namely, a few very minute crystals of yellow muscovite (sericite), and some irregular masses of pale brownish-yellow, lime-alumina garnet (grossularite). The corners of the feldspar crystals are mostly quite sharp, but a few are well rounded, as if they had suffered considerable attrition in the original magmatic flow. There are a few transverse fractures, but hardly any displacement. The edges of several crystals have been metamorphosed to albite. A measurement of the extinction angle on center and margin gives me: Lab.-Alb. $= - 47° 55'$, in which, assuming an uncorrected albite angle of $+ 18°$, there

remains an uncorrected labradorite angle of $-29° 55'$. I apply to these proportional corrections, namely, for albite $+1°$, giving the true albite angle $= +19°$; and for labradorite a correction of $-1° 30'$, giving true angle $= -31° 25'$; which corresponds to a labradorite formula of albite 1, anorthite 4. A mean of the extinctions on opposite sides of a twinning plane in a typical labradorite crystal gave $-31° 18'$, which agrees with the previous determination of Ab_1An_4. The crystals, 1 or 2 mm. wide, and 5 to 10 mm. long, form a pretty closely parallel ophitic structure. A few crystals show Carlsbad twinning.

The ground-mass between the parallel feldspars is made up of a micro-crystalline mesh of the same material with very fine crystals (0.01 mm.) of a dark green pleochroic mineral, which appears to be biotite, and with equally minute crystals of magnetite, together with some titanite. The crushed mineral is almost entirely decolorized by boiling hydrochloric acid. Irregular larger masses of ilmenite with titanite borders, and masses of green biotite (1 to 2 mm. in diameter) in fine crystals, pleochroic with green and brown colors, complete the inclusions within the ground-mass. Dr. G. F. Loughlin, who helped me identify some of the minerals, is of the opinion that the rock has been "contact-metamorphosed, presumably by granitic intrusion, which set free heated water with potash and fluorine. These changed the original ferromagnesian minerals into biotite, and a little of the ilmenite and feldspar into titanite, garnet, sericite and secondary albite." The material is completely crystalline and has a decidedly fresh look, the fracture sparkling with minute crystalline facets.

Frank W. Very

Westwood, Mass.

THE NORWOOD METEORITE (?)

As Professor Very, in Science of January 28, 1910, has seen fit to place on record the discovery of a stone claimed to be a meteorite, but unlike any meteorite hitherto known, a petrographic description of the stone may be of interest. The writer has discussed the matter with Professor Very, and at his suggestion, viewed the stone (on exhibition in Austin & Stone's Dime Museum), visited the spot where it was discovered and examined a thin-section which Professor Very furnished.

The stone may be called, megascopically, a basalt-porphyry. Its color on fresh fracture is nearly black, its luster rather dull. The ground mass is extremely fine-grained to felsitic. It is sprinkled with tabular phenocrysts of labradorite (about 30 per cent. of the rock) and with a few small grains of ilmenite. The natural surface is gray. There are no noticeable oxidation effects, but the ground mass has suffered marked corrosion, such as is produced by swamp waters, leaving the plagioclase phenocrysts in pronounced relief. The latter are greenish-gray, tabular with rounded corners and measure up to 12 or 15 mm. in length. They show in general a parallel arrangement, or flow structure.

The slight salty odor of the stone mentioned by Professor Very was not noted, but may well have been lost in the characteristic atmosphere of the dime museum.

The minerals noted in thin section are labradorite and ilmenite, both as phenocrysts and in the ground mass, biotite, titanite, garnet and sericite, with a little albite (?), epidote and kaolin. The ground mass consists chiefly of plagioclase and biotite. The labradorite phenocrysts show excellent Carlsbad and albite twinning. Both the phenocrysts and the feldspars of the ground mass are but slightly kaolinized, but are partially replaced by garnet, titanite and sericite. The garnet forms irregular grains fingering into the feldspar or the ground mass. The titanite forms rings around ilmenite grains, in some instances fingering into feldspar crystals. The sericite is sprinkled through the feldspar phenocrysts and the ground mass in typical minute flakes, single or in aggregates. The biotite is finely disseminated throughout the ground mass and in a few places is bunched into fine-grained aggregates, strongly suggesting replacement of some femic phenocryst. No trace, however, of any other femic mineral was noted. Only two small grains of

epidote, clearly of secondary origin, were found. The albite (?) could not be positively identified, but was clearly secondary.

The minerals and their associations just described indicate that the rock has suffered hydrothermal alteration, presumably near the contact of some plutonic intrusive. It therefore remains for the meteorite specialists to decide whether or not a newly fallen meteorite may be similar in mineral characters to hydrothermally altered terrestrial rocks. Professor Very's argument is that absence of pronounced kaolinization and ferruginous staining are good evidence that the stone is not a glacial boulder; but opposed to this argument is the fact of the corroded surface. The stone was discovered near the top of a gentle slope and certainly could not have become so corroded at that point. There is a swampy tract at the base of the slope. Could the stone have been corroded there and later been removed to the point of "discovery"?

Professor Very's argument that the stone is a meteorite is based, in short, partly on absence of kaolinization and ferruginous staining, but chiefly upon the verbal testimony cited in his article; the writer's argument to the contrary rests on the altered character evidenced by mineral relations, and the swamp-corroded surface, which coupled with the point of discovery, are at least suggestive of fraud.

G. F. LOUGHLIN

MASSACHUSETTS INSTITUTE
OF TECHNOLOGY,
February 8, 1910

QUOTATIONS

ANOTHER ROSS CASE

TEN years ago Professor E. A. Ross was dismissed from Leland Stanford University because Mrs. Stanford was offended by the active part he took in the campaign for free silver and by his extreme language in opposition to Japanese immigration. Last week he was publicly rebuked by the regents of the University of Wisconsin for exposing his students to the influence of dangerous agitators. The text of the resolution is as follows:

"Whereas, It has come to the knowledge of the Board of Regents that Professor E. A. Ross, of the department of sociology in our university, has invited to lecture in the university and under its auspices, persons whose record and expressed views are subversive of good morals, therefore be it

"Resolved, By the Board of Regents that we strongly disapprove of such action, and that the president of the university is requested to inform Professor Ross of the censure of the board and their unanimous disapproval of his indiscretions."

The disturbance originated in the visit of Emma Goldman to Madison, where she gave a lecture in a downtown hall in no wise connected with the university. She visited the university and was shown through it, but her request to be allowed to address classes was refused. Later, however, she was invited by a socialist club of students to speak at their meeting in the Y. M. C. A. building. Professor Ross, referring in his classes to the fact that a woman was tearing down the cards announcing the lecture, took occasion to express himself in favor of free speech and mentioned the Goldman lecture downtown that evening, at the same time stating his disapproval of such anarchistic teachings.

This, however, was made the basis of a sensational attack by certain newspapers of Wisconsin upon the university for using the facilities provided at the expense of the taxpayers for the promulgating of anarchistic and immoral doctrines. The Board of Visitors appointed a committee to examine instructors, students, lecture notes and textbooks in the department of political economy and came to the following conclusion:

"This investigation disclosed nothing that would warrant the charge that anarchistic, socialistic, or other dangerous doctrines are being taught in the university. On the contrary, investigation disclosed striking instances of foreigners who have come to the university as students believing in anarchism and violence, who have been led to discard such beliefs through the instruction given at the university.

"The general purpose of the instruction given was stated to be not to prove or disprove any particular theory or doctrine, but to enable the student to know and to understand facts and conditions; to fit him to solve for himself the problems of government and of society, rather than to send him forth with a solution for all the problems that he may encounter.

"The Board of Visitors finds that the instruction given in the university, including that given by Professor Ross, is such as to strengthen, not to weaken, respect for government and the institutions of existing society.

Evidently the Board of Regents takes a more serious view of the case than the Board of Visitors but they agree that Professor Ross has been indiscreet. So does Professor Ross, for in a letter to President Van Hise he frankly acknowledges that he should not have alluded to Miss Goldman's lecture in his classes and promises not to commit that sort of a mistake again. We hope, therefore, that he will not feel that the censure of the regents makes it incumbent upon him to resign, and we hope that the regents will not feel it necessary to impose any further restrictions on freedom of expression by members of the faculty.—*The Independent.*

SCIENTIFIC BOOKS

Researches on Fungi. An account of the production, liberation and dispersion of the spores of Hymenomycetes treated botanically and physically. Also some observations upon the discharge and dispersion of the spores of Ascomycetes and of Pilobolus. By A. H. Reginald Buller. London, New York, Bombay and Calcutta. Longmans, Green & Co. 1909.

For several years Dr. Buller has been engaged in studying the biology of certain species of Hymenomycetes with special relation to their response to external natural stimuli, to the mechanism of spore discharge, the velocity of spore fall, the adaptation of the spores for wind dispersal, and the correlation of the structure and development of the fruit bodies, with their adjustments, for the production and dissemination of spores. A few papers have already been published in the *Annals of Botany* and the *Journal of Economic Biology*, dealing with the biology and adjustments of *Polyporus squamosus* and *Lentinus squamosus* (*L. lepideus*), but the larger body of interesting results are here published for the first time. It constitutes a notable contribution to the biology of the fungi, especially in regard to the question of spore discharge and spore fall in the Hymenomycetes, and the remarkable adjustments of the plants which assure the dissemination of myriads of these minute reproductive bodies.

Under the influence of gravity the geotropic curvature of the stem of certain agarics has been shown by Dr. Buller to exhibit the same phenomenon of geotropic swinging or swaying which occurs in the shoots of seed plants. He first observed this in *Coprinus plicatilis* where there was an overtilting or supracurvature four times before it came to rest in the perpendicular position. *Coprinus plicatiloides* Buller, a very minute species growing on horse dung, is remarkably sensitive, one plant curving through 90° in 17.5 minutes. This species also shows geotropic swinging, the successive supracurvatures of the individuals mentioned being 28°, 8°, 1°, 0°.

It has long been known that gravity influences the direction of growth of the stem of many agarics, the stems being negatively geotropic, and the horizontal development of the pileus of many woody or corky species of the Polyporaceæ, the fruit bodies of these plants being diageotropic. These adjustments under the influence of gravity have been recognized as of the greatest importance in permitting the fall of the spores from between the closely approximated gills of most agarics and from the long narrow tubes of most polypores. Dr. Buller has now placed the interpretation of some of these phenomena on a sound experimental basis and has shown also the variations and limitations of the influence of gravity in relation to the adjustment of position of the different parts of the fruit body in

some half a dozen species. *A. campestris* responds in two ways to the influence of gravity —(1) the adjustment of the pileus in a horizontal position by the negatively geotropic stem, and (2) the finer adjustment of the gills by their positive geotropism. These two adjustments he speaks of as the coarse and fine adjustments, the positive geotropism of the gills placing them in a perpendicular position with reference to the earth in case the pileus should be slightly tilted from the horizontal.

Polyporus squamosus responds in four ways to the influence of gravity—(1) the negative geotropism of the stem after the initiation of the fruit body under the morphogenic influence of light, (2) growth of the pileus parallel to the earth's surface, (3) growth of the pileus with a symmetry suited to the position of the stipe, (4) growth of the hymenial tubes downward. *Agaricus campestris* is indifferent to light, while the fruit body of *Polyporus squamosus* is only initiated under the influence of light. The difference between the two species in the number of responses made to external stimuli, the author says, is correlated with the fact that one fungus grows on a tree and the other on the ground. While this correlation does exist it does not wholly explain the fundamental difference in behavior. One must take into consideration the difference in the origin of the plant parts, as well as the necessity of a permanent position of the stratum of tubes compared with the change in an agaric, provided the pileus has a general horizontal position, since the gills may descend or ascend from the stipe as the margin of the pileus is elevated and yet spore fall may not be interfered with.

The number of spores produced by a single fruit body was estimated in several species and the enormous number probably far exceeds the estimates and shows how prolific these plants are. An individual of *Agaricus campestris* produces about 2,000,000,000 spores, *Coprinus comatus* about 5,000,000,000, *Polyporus squamosus* about 11,000,000,000, and an individual of *Lycoperdon giganteum*, 40 $\times$ 28 cm. (16 $\times$ 11 inches) about 7,000,000,000,000. Single fruit bodies of some plants shed spores at the rate of 1,000,000 a minute, and this may be kept up for several days. Notwithstanding this enormous prolificness the waste is enormous because of the small chance of a spore being able to produce a new plant. He estimates that in *Polyporus squamosus*, considering also the perennial character of the mycelium, about one spore in 1,000,000,000,000 has a chance of starting a new successful cycle. The spores are sometimes shed in such vast numbers that they can be seen in clouds floating away from the plant. A species of *Polyporus squamosus* which was growing in a greenhouse shed such vast numbers that, when one entered in the morning and at other times, the air was so filled with spores it appeared as if some one had been smoking there. This continued for thirteen days and the plant continued to shed spores for three weeks. The spore-fall period varies in different individuals of a species. It was determined for several species, and the following examples are given: For *Coprinus plicatilis* a few hours, *Agaricus campestris* two to three days, *Polystictus hirsutus* five days, *Lenzites betulina* ten days, *Polystictus versicolor* sixteen days, *Schizophyllum commune* sixteen days, *Polyporus squamosus* three weeks.

One of the remarkable discoveries is the fact that many xerophytic fungi which have been preserved dry for several months or years may be revived by moistening, when spore fall will be resumed and continue for several days or weeks, even after the plants have been dried and revived several times in succession. Thus *Corticium læve* revived after one year shed spores, *Phlebia pileata* (*Phlebia strigosozonta*) after two years and eight months, *Polystictus versicolor* two years, *P. hirsutus* three years, *Schizophyllum commune* two years, *Trogia crispa* four months, *Lenzites betulina* three years, *Marasmius oreades* six weeks, *Collybia dryophila* one week. Spores of *Daedalea unicolor* and *Schizophyllum commune*, after the fruit bodies had been kept dry for three years, shed spores which were capable of germination as determined by test. This demonstrates that

the shedding is an active process and that the plants were still alive. These two species are the only ones so far tested by the author for germination after such a long period of drying.

The spores are forcibly ejaculated from the sterigmata and fall down from between the gills or from the tubes. Thus spores of *Amanita vaginata* are shot outward with an initial velocity of 400 mm. per second to a distance of about 0.2 mm. The terminal vertical velocity of falling is about 5 mm. per second, while the spore is moist, but it soon becomes about 3 mm. as it dries. For most other species with smaller spores the spores are shot out for 0.5–0.1 mm. and the terminal vertical velocity is about 1–2 mm. per second. The horizontal discharge is so rapid that it can not be seen even with the aid of the microscope.

The terminal vertical velocity is reached in about one four-hundredth of a second. In actual observation and experience, however, the terminal velocity of fall is reached later, owing to the fact that the spores lose water rapidly by evaporation so that the velocity becomes reduced to one half in some and one third in others, the loss of water occuring even in a small compressor cell which contained wet blotting-paper and a drop of water, owing to the relatively high vapor pressure in the small spores whereby moisture passed over by distillation to the large drop of water. The more rapid fall, however, takes place while the spore is passing from between the gills or from the tubes, in consequence of which there is less danger of convection currents carrying them to the wall where they would adhere.

The mechanism of spore discharge in the Hymenomycetes receives special consideration. Several previous investigators have stated that the spores are squirted from the ends of the sterigmata by the bursting of the latter under hydrostatic pressure. Dr. Buller shows very conclusively that in the species studied by him and probably in all the Hymenomycetes this method of spore discharge is impossible. His reasons are as follows: (1) The successive, not simultaneous, discharge of the spores from a basidium. If the spores were squirted off, the basidium would lose its turgor after the discharge of the first one and the others would remain attached, (2) the absence of drops of liquid on the ends of the sterigmata, (3) the apparent closed condition of the sterigmata after discharge, (4) non-collapse of sterigmata and basidia as the spores disappear. While he is not able to state definitely the mechanism of discharge, owing to the very minute size of the point of the sterigma, he arrives at a very reasonable conclusion as to the mechanism. It is that of the existence of a double wall at the junction of the sterigma and the spore so that endosmotic pressure in the basidium and spore causes the rupture of the lateral wall connecting the edges of this double wall. This probably occurs somewhat in the same manner as the sudden breaking of threads of *Spirogyra* in consequence of the high endosmatic pressure of adjacent cells after the middle lamella of the wall has disappeared.

The trajectory described by the spore from the time it leaves the sterigma and follows its vertical path of fall is called the "*sporabola*." It was impossible to observe any portion of the sporabola except the path of vertical fall, since the velocity of discharge is so great, the initial velocity of a spore on leaving the sterigma being 40 cm. per second. The initial velocity is determined from mathematical formula, since the maximal horizontal distance of projection and the terminal vertical velocity of fall are determined by actual observation. These being known by mathematical formula, the sporabola can be plotted. The sporabola is remarkable in that the horizontal part passes with a very sharp curve into the vertical part, and the total declination on the horizontal path is approximately equal to the diameter of the spore. The very rapid slowing down of the horizontal velocity is due, of course, to the enormous friction which the relatively large surface of the minute spore offers to the air, and for the same reason the vertical velocity is very slow. Here is shown a very beautiful instance of correlation to structure and means for distribution. The gills of most agarics

are very close together, from two millimeters to several millimeters apart. If the spores were not shot for some distance from the surface of the gill of the agaric, or tube of the polypore, they would fall upon the surface of the hymenium, and because of their adhesiveness could not escape. If they were shot too far they would strike the hymenium opposite and adhere. In *Agaricus campestris* they are thrust horizontally for about 0.1 mm. and in *Amanitopsis vaginata* about 0.2 mm. They then fall very slowly, and after passing below the gills are easily wafted away by even slight air currents.

The deliquescing Coprini represent another type of fruit body from that of other Hymenomycetes in the very high specialization which has taken place in the adaptations for spore dispersal. *Coprinus comatus*, the shaggy mane mushroom, will illustrate this type. The pileus is large and cylindrical, so that the broad, long gills stand vertically between it and the stem. The gills are very close together. At their edges are numerous projecting large cystidia which are connected with those of adjacent gills. If the basidia and spores matured simultaneously over the entire surface of the gills, or over any considerable portion, as in other agarics, very few of them would ever reach the outer air, since they would lodge on the surface of the gills or upon the numerous large cystidia on the sides of the gills. The basidia and spores are matured, first over a narrow zone occupying the edge at the lower end of the gills. The cystidia on the edges of the gills are dissolved by autodigestion. When these spores are shot off they readily reach the air below by falling. This now sterile part of the gill, by autodigestion, is reduced to a liquid condition. It is blackened probably by an oxydase which unites with certain substances. It is covered by a thin film and by evaporation becomes thinner, so that the spores from a narrow zone next above can readily fall down in the wider spaces thus formed, and so on. At the same time the pileus begins to expand more rapidly at the margin so that by the time the ink drops begin to fall they are out of reach of the falling spores. In contradistinction to the belief held by some that the spores of the Coprini are mixed with the inky fluid and that they are then disseminated by insects,[1] the author believes that under normal conditions very few if any spores are caught in the liquid, and that the spores are anemophilous.

The adjustments of the fruit body of *Coprinus comatus* are as follows: (1) A large number of gills with a very great spore-bearing surface, (2) a thin pileus, thus economizing energy in its development, but incapable of expanding and lifting the weight of the gills, (3) the spacing of the basidia by paraphyses assuring the free projection of the spores, (4) the nearly simultaneous expulsion of the spores from all of the basidia of a narrow zone at the lower edge, (5) the autodigestion of this zone to provide space for the fall of the spores shot from the basidia of an adjacent higher zone, and so on, (6) the gradual expansion of the pileus from its margin inward after autodigestion of the sterile parts of the gills removing the fluid parts from interference with the fall of spores from the successive zones of spore ejection, (7) the continued elongation of the stipe lifting the gills higher so that the spores are more easily caught by air currents.

These adjustments the author believes indicate a higher degree of specialization on the part of the Coprini and that, instead of being a primitive group as suggested by Massee[2] (p. 130), they represent the highest development and specialization of the Agaricini.

In many of the Ascomycetes, as has been long known, the spores are squirted out from the ascus. In *Peziza repanda*, with narrow cylindrical asci, the spores are shot out in a chain along with some of the liquid. The difference in momentum given the successive spores of the chain, together with the spontaneous segmentation of the liquid cylinder in which they are imbedded according to a well-known physical law, separates the spores in the air so that they are wafted away by the

[1] See Fulton, *Ann. Bot.*, III., 215, 1889.

[2] Massee, Geo., "A Revision of the Genus *Coprinus*," *Ann. Bot.*, X., 125–184, pl. 10, 11, 1896.

wind. This represents a type of the Ascomycetes adapted to wind dissemination of the spores. Another type is represented by *Ascobolus immersus* with broad elliptical asci, and large spores which are held together by a broad gelatinous investment so that they remain in a group as a single projectile as they are shot from the ascus to a distance of 20–35 cm. This mass, which is 2,000 times the volume of a basidiospore, is too heavy for wind dispersal. It falls on the surrounding herbage where the spores may be devoured by herbivorous animals and gain dispersal after passing through their digestive tract.

The rate of fall of the spores of the Hymenomycetes was used to test the theory known as Stokes's law relating to the fall of microscopic spheres in air, and it was confirmed to within 46 per cent. For determining the velocity of spore fall under direct observation through the microscope the author employed an ingenious device of an automatic electric recorder, the position of a spore, as it successively passed by spaced horizontal threads in a Ramsden ocular, being registered by a tapping key controlled with the left hand.

The illustrations and press work of this book are good, and besides the very interesting and important discoveries, it is full of stimulating suggestions and possibilities for further investigation.

Geo. F. Atkinson

Charles Darwin and the Origin of Species. Addresses, etc., in America and England in the year of the two anniversaries. By Edward Bagnall Poulton. New York, Longmans Green and Co.

It is fitting that upon November 14, 1909, the anniversary of the publication of the "Origin of Species," there should be published this memorial volume; fitting also that it should be written by a friend and advocate of Darwin's views in their entirety. Besides the addresses the volume contains some unpublished letters of Darwin and also a preface in which the author takes occasion to express his attitude toward the modern contributions to the study of evolution.

Nothing is more evident than that the younger generation of scientists has departed somewhat from the Darwinism of a generation ago. That fifty years' study of Darwin's great theories, by both friends and enemies, has established the general theories of which he was the most notable advocate upon an unshakable basis is very clear. But equally clear is it that this same half century has raised difficulties as to Darwin's special explanation of the method of evolution; difficulties so great that most of the younger generation of scientists are unable to accept Darwinism in its entirety as an all-sufficient theory. These difficulties have arisen not simply in the minds of Darwin's enemies, but in those of his friends also. That some solution of these difficulties is to be found is the belief of every admirer of Darwin, and moreover every admirer of Darwin must feel that this great master so fully exhausted the study of his great law of natural selection that little can be hoped for further study along the same lines. It is difficult to resist the belief that the removal of the difficulties that have arisen must come along new lines of study and not by the further exploitation of the old ones.

Poulton, however, apparently thinks otherwise and conveys the impression of holding that of the modern theories, that which is new is not true and that which is true is not new. The only real contribution to the discussion since Darwin that Poulton admits is Weismannism, and this he admits, seemingly, simply because it places the great theory of Darwin in a position "far higher than that ever assigned to it by Darwin himself." Of the mutation theory, which most thinkers today recognize as at all events decidedly stimulating, Poulton can only speak with a sneer, both at the theory and at its chief exponent. Some of Darwin's friends have been pleased to feel that Darwin really recognized mutations under the phrase "evolution per saltum" as a part of his theory. But Poulton is at pains to repudiate this idea entirely and to insist that Darwinism is a theory of evolution by minute steps and one of which any conception of mutation forms no part.

One can hardly fail to feel that this refusal to look with charity upon anything new only weakens Darwinism, and can but believe that Darwin himself would have been rather more broad minded. Darwin's position as the most stimulating mind of the nineteenth century stands secure, and he may well be ranked with Newton as one of the two great men that England has thus far produced. In this position he remains no less securely even if we do admit that the details of his great theory do not work out in all respects as he imagined them to do. We admire him not the less, but rather the more, as we learn that the descent theory, which must ever remain associated with Darwin's name, agrees with newly discovered facts as well as with those which Darwin himself knew.

But this volume of essays is written by an advocate, as eminently fitting for an anniversary volume, and it will form a necessary part of the Darwin bookshelf. Any light upon the personal life of the world's great men always has its interest and many a touch upon the life of Darwin given in these papers helps to render the great Englishman a live personality. The life of the man, his long struggle with ill health, his kindness and thoughtfulness for others amid his own suffering, his eagerness to give others even more than their share of credit for his discoveries and his own proverbial modesty, are anew impressed upon us as we read the unpublished letters and the newly given incidents in his life. The oft-quoted loss of appreciation of music and art, which Darwin admitted in his later life, are attributed by Poulton not to the result of scientific study, but to his constant suffering and ill health that made it impossible for him to have any comfort save in the, to him, one all-absorbing occupation of scientific study.

One new contribution of scientific knowledge is found in this volume in an essay upon "Mimicry in the Butterflies of North America," originally read in Baltimore in 1908. Complete mastery of this interesting subject is shown with a wealth of illustrative material. The historical development of mimicry in the western continent is traced in ingenious detail. But Poulton adds nothing, and admits that he can add nothing, to the puzzling question of the *cause* of mimicry. This still remains as great a puzzle as it has ever been, although it is enriched with an abundance of illustrative material by means of which Poulton is enabled to follow the migrations into North America of the successive types of butterflies.

H. W. CONN

SPECIAL ARTICLES

THE EARLIEST DESCRIPTION OF ŒNOTHERA LAMARCKIANA

IN working over the early records of *Œnothera Lamarckiana* I have recently discovered in the Sturtevant collection of the library of the Missouri Botanical Garden, a remarkable manuscript which proves that this plant was originally a species growing wild in Virginia, and that it was the first *Œnothera* introduced into European gardens, about 1614. There has been so much obscurity and doubt regarding the origin and early history of *O. Lamarckiana,* the plant upon which the weight of DeVries's mutation theory largely rests, that a document which proves definitely the facts just stated must be regarded as of prime interest and importance. The frequent claim that *O. Lamarckiana* probably originated in cultivation, either through hybridization or otherwise, is here shown to be without sufficient foundation.

The record in question is a long marginal note in a copy of Bauhin's "Pinax," published at Basil in 1623. The note is written in Latin, in archaic English script, and gives an accurate description of *O. Lamarckiana* as we now know it, though differing somewhat in one or two minor characters. The plants were grown from seeds obtained from Padua in 1619, and the description is evidently written from the living plants. It is remarkable for its accuracy, considering the time it was written, equaling in this respect descriptions which were published much later. The author of the marginal note is apparently one Joannis Snippendale, whose name, in similar handwriting, appears on the title page of the

book. The plant is described under Bauhin's name, *Lysimachia lutea corniculata,* the closely written description covering the whole margin of the page. Numerous marginal notes on other plants, by the same author, are found scattered all through the volume. Among the points mentioned in the description which make it certain that this plant was *O. Lamarckiana* and not *O. biennis* or *O. grandiflora,* the forms with which it has most frequently been confused, may be mentioned the following: (1) the flowers are large, 3 or 4 inches long; (2) the rosette leaves are long, pointed and obscurely sinuate; (3) there is present on the branches a type of hair arising from red papillæ;[1] (4) the buds are quadrangular. The first character distinguishes the plant from *O. biennis,* while either of the characters (2) or (4) make it certain that the plant is not *O. grandiflora.*

The differences from the *O. Lamarckiana* of our present cultures are that the rosette leaves seem to be narrower and paler green, and there are secondary branches. The last point is sometimes true of our present *O. Lamarckiana.* The characteristic crinkling of the leaves is not mentioned in this account; but it is definitely described in an independent account of an *Œnothera* from Virginia, published by another author in 1651.

This marginal note is the earliest description of an *Œnothera* now known to exist. I have not yet been able to learn anything regarding its worthy author, but he may have been connected with a garden in England, and he was certainly a close observer. The record is as complete and accurate as could be desired, to prove to one familiar with the characters of these forms the identity of the plants in question. It is safe to say that there are few American plants of which there is such an early accurate record as this.

DeVries called attention, in 1905, to records which showed that the *O. Lamarckiana* at present found in European gardens, and from which the plants of his cultures also originated, was introduced into Europe from Texas in 1860. The manuscript here referred to shows that the Virginia plant was very similar to, and possibly identical with, the form from Texas.

[1] This character is also present in some forms of *O. grandiflora.*

Other records, which I shall not refer to here, show that *O. Lamarckiana,* which must have been derived from the Virginia plants, had escaped and was growing wild in England as early as 1805, and probably much earlier. Cultures of this English form by MacDougal, and more recently by myself, have shown it to be almost or quite identical with the *O. Lamarckiana* of DeVries's cultures.

Owing to the authority of Linnæus, later writers failed to distinguish between large-flowered and small-flowered forms, both going under the name of *O. biennis.* Not until after *O. grandiflora* was introduced into Kew from Alabama in 1778, was *O. Lamarckiana* segregated as a separate form; first described by Poiret under the name *O. grandiflora,* for which Seringe afterwards substituted the name *O. Lamarckiana.* An unpublished description of *O. grandiflora* Ait., by L'Heritier, dated about 1788, is far more complete than the brief characterizations of Aiton and Willdenow, and is important in proving that the *O. grandiflora,* as we now know it from Alabama, was the form described. This manuscript I have also seen.

Photographs and transcriptions of these manuscripts, together with other important historical data regarding these forms, whose identity has been subject to question, will be published at another time. Of these records, the first mentioned is evidently of extreme importance, showing as it does that a form at least closely similar to our present *O. Lamarckiana* was the first *Œnothera* introduced from Virginia into European gardens, and hence that it did not originate in cultivation.

R. R. GATES

MISSOURI BOTANICAL GARDEN

OPHIDIAN NOTES AT THOMPSON'S MILLS, NORTH GEORGIA

THE scarlet snake (*Cemophora coccinea* Blumenbach) appears to be more or less widely

distributed throughout the higher piedmont region of Georgia. During the spring of 1909, the writer captured two individuals at Thompson's Mills, North Georgia. One, a very small specimen, was found beneath some rocks in a dry, upland thicket, beneath which was a vigorous growth of *Opuntia opuntia*. The second specimen, which was of rather large size for the species, was dug from soft, rich soil in low ground bordering a small creek. The scarlet snake is very beautifully patterned above with scarlet, orange and black. It is a rather sluggish creature and is perfectly harmless, usually making little effort to escape when handled. Owing to its habit of keeping concealed beneath rocks, decayed logs or soil, this little snake is not frequently seen. Although the scarlet snake can not be considered a common species in this region, yet many of the farmers here claim they have met with them, usually during spring plowing. The scarlet snake probably occurs at higher altitudes in Georgia, though less frequently. It has been taken at Gainesville, Georgia.

Until the summer of 1893, when a specimen of this snake was taken in the District of Columbia, its range was recorded only from South Carolina, throughout the Gulf States to the Mississippi, mainly in the coastal plain area. Although it appears most abundant in the low, sandy coastal areas of the southeastern states, and has been considered typically an austroriparian form, it is without doubt also well represented in Georgia throughout the Carolinian area, and the limits of its range come very close to the mountains.

The copperhead (*Ancistrodon contortrix*) Linn. is occasionally taken in the Thompson's Mills region. This reptile is widely distributed throughout the east from New England to Florida and beyond the Appalachians to Illinois. In the Thompson's Mills region the copperhead is confined generally to more or less wooded, dry upland situations. It especially prefers dry, rocky hillsides. Its rich brown mottlings of various shades harmonize it well with the soil and dead leaves of thickets and open rocky woods, which it frequents. The food of the copperhead consists of various small creatures as frogs, mice, etc., and very probably caterpillars and insects also. At Thompson's Mills, in October, 1909, the writer saw a pair of large copperheads killed in a shallow ditch on a dry, wooded hillside. Both were lying stretched out together in the sunshine when killed. It was discovered that one of these had in its mouth a very large, hairy caterpillar frequently seen in oak woods.

The copperhead is one of our dangerously poisonous snakes, but will usually try to escape quietly if given a chance. It should be particularly looked for around rocky cliffs in dry woods, for this is its favorite habitat. The writer well remembers meeting a copperhead in this situation while collecting ferns. He had jumped down into a shallow, rock-enclosed hollow filled with leaves. There was a sudden commotion beneath his feet of some creature trying vigorously to escape, which at first thought he concluded must be a rabbit. On glancing down, it was something of a surprise to see a huge copperhead securely pinned down by his weight. It took but an instant to leap completely clear of snake and hollow, and the reptile slowly made its escape among the rocks.

H. A. ALLARD

BUREAU OF PLANT INDUSTRY,
WASHINGTON, D. C.,
December, 1909

ON CHANGES OF ATMOSPHERIC PRESSURE IN NORTH AMERICA

IN order to arrive at a clear understanding of the complex phenomena of periodic or non-periodic climatical changes—and the effect they have on the yield of crops—I found it necessary to approach these problems in a very systematic way.

It seemed to me that two kinds of investigations had to be made simultaneously.

Firstly, the research of the meteorological causes having affected the crops, during different years in different countries. In the case of the United States it would be easy to draw conclusions from the great amount of information collected and published by the de-

partment of agriculture, if this information were only coordinated according to the needs of such a research.

Secondly, to find and then to solve, one by one, the problems of dynamical climatology.

Working along this line and leaving aside, for the present, the continuation of my study on modes of formation and progressive displacements of the thermopleions and antipleions,[1] this study being extremely difficult, I found simpler and more fundamental phenomena by drawing maps of the annual departures of atmospheric pressure.

These maps led me indeed to most unexpected conclusions.

Considering the data of the tables of "barometric pressure" of Sir Norman Lockyer, and utilizing the departures given in Bigelow's report on atmospheric pressure, as well as those published in the annual summaries of the *Monthly Weather Review,* I drew curves showing the geographical distribution of equal departures.

I found that, with few exceptions, the areas of positive and negative departures displace themselves from east to west, from the Atlantic across America toward the Pacific. In reality, however, the movements of the areas of hypo- and hyper-pressure are very complicated, there being generally two distinct directions of propagation simultaneously apparent. Some maps show clearly the existence of intercrossing waves coming from beyond the northeast and southeast of the United States.

These waves are extraordinary because of their slow progress. To verify the fact that waves of hyper- and hypo-pressure of the map of a given year are really those of the preceding year displaced westward, I have calculated consecutive annual means.

The diagrams of these figures—for stations situated along the presumed path of a center of too low or too high annual pressure—show that it is really with a wave movement, of a particular kind, that we have to deal.

I shall not dwell on the details, this being but a preliminary notice of a paper which will be published in the *Bulletin of the American Geographical Society.* I must state, however, that my method of utilizing consecutive means, which makes it possible to draw yearly maps from month to month, will enable me to foresee the changes which will occur.

To know how far this method may be applied to forecast seasonal distribution of pressure, I must first investigate the yearly variations of pressure, and calculate the consecutive means of many series of observations, to find out if there is not a periodicity in the long-range atmospheric waves.

From the discussion of annual maps it appears most probable that the amplitudes of those waves increase and decrease in harmony with the sun-cycle of about eleven years.

Henryk Arctowski

New York

[1] Arctowski, "L'enchaînement des variations climatiques," Bruxelles, 1909.

COLLEGIATE INSTRUCTION

The Committee on College Instruction of Section L, of the American Association, recently ordered the publication, if practicable, of certain samples of the facts obtained in a study of (1) the size of classes (a "class" being defined as a group of students dependent upon one teacher for instruction in a course) and of (2) the actual work done by individual students in fulfilment of the requirements for the A.B. degree. By the courtesy of the editor of Science, these facts are now printed.

Size of Classes

In almost all colleges that report the conditions of instruction in this particular, there is an enormous variability in the size of the groups taught by a single teacher in undergraduate courses. Within the same institution the number will commonly range from three or even fewer to a number equal to a fifth of the entire student body. The facts in this regard have been reported, though not every year, and not without many ambiguities, by Boston University, Bowdoin, Brown, Bryn Mawr, University of California, Harvard, Johns Hopkins, Stanford, Oberlin, Radcliffe, University of Texas, Tufts, Western Reserve,

Williams and probably by a number of other institutions.

Because of the ambiguities of the reports in respect to the exact number of sections, the exact share taken by each officer of instruction engaged in a course, the conduct of laboratory and composition courses and the like, it was not possible, without asking much assistance from many colleges, to determine the exact frequencies of classes of all sizes. But the figures of Table I., which are approximately correct, will give a sufficient idea of this enormous variability. It is even greater in large colleges like the University of California, Harvard or Stanford.

TABLE I

Relative frequencies of different sizes of class in American colleges, a class being defined as a group taught by only one person. In per cents.

Size of Class	Boston University	Brown	Wesleyan	Bowdoin	Beloit	Knox	Wabash
1–9	16.5	38.9	36.6	22.8	42.5	27.5	82.5
10–19	13.2	26.2	22.8	22.8	25.2	25.0	14.2
20–29	14.8	17.6	19.5	22.8	18.1	12.5	26.4
30–39	11.5	9.5	8.1	9.8	4.7	12.5	14.2
40–49	3.8	2.1	2.4	9.0	2.4	12.5	2.0
50–59	3.8	1.7	4.9	6.5	1.6		
60–69	3.8	2.1	.8	4.1	1.6	3.8	2.0
70–79	4.9	.5		.8	1.6		
80–89	4.9	.5	.8[2]	.8			
90–99	4.9	.2				1.3	
100–109	3.8					3.8	2.0
110–119	3.8	.3		.8[3]	.8		
120–129	2.7	.5					
130–139							
140–149	.5[1]						

There is also great variability amongst institutions with respect to the provision for teaching the same subject-matter. The first- and second-year courses in French and German, for example, are, in one college, given to sections of 13 students and, in another, to sections of 41 students. The first course in philosophy or in psychology is in some institutions divided into sections of 40 students, while in others the entire class of two hundred or more is left to one teacher, with presumably some assistance in the examination of written work. Similar differences exist in the case of all departments enrolling many students. In some institutions the enrollment is less than ten in only a sixth of the classes, while some devote nearly half of the teaching hours of their staff to the conduct of classes of less than ten students.

[1] Also 1.1 at 200 and .5 at 220.

[2] A course in chemistry. Help in the laboratory is probably given by others than the one instructor.

[3] A course in hygiene.

It is not the purpose of this report to discuss this condition of college teaching, but it is the committee's opinion that the following questions are worthy of discussion in college faculties and by those responsible for the financial provision for college instruction.

1. Is not the number of students taught at one time by a single individual in many college courses so great as to reduce that individual's knowledge of the attitude, preparation, difficulties, errors and achievements of his students to almost zero?

2. Is not the number of students taught at one time by a single individual in many college courses so small as to involve an enormous waste of the instructor's time and an improper distribution of the appropriations for teaching?

3. Other things being equal, should not the teaching of more than 40 college students at one time by one person be avoided? Should not any department have reasons of weight for any such case?

4. Other things being equal, should not the use of a quarter or more of a professor's teaching hours for a year for the instruction of fewer than ten students in one undergraduate course counting one twentieth or less of the degree's total requirement be avoided? Should not any department have reasons of weight for any such case?

5. Should not the traditional method of having the ratio which the number of class meetings is to the number of "points" credit the same, regardless of whether the class enrollment is 1, 5, 10, 20 or 100, be abandoned in many of the undergraduate courses enrolling less than 10 students?

6. When, in a college course given annually, the number of students is less than 6, should not the course be offered only once in two years, except for reasons of weight?

The Actual Curricula of Individual Students

The committee gathered 500 complete records of the courses taken for the bachelor's degree by students representing random samplings of the class of 1909 in the following institutions: Beloit (27), Bowdoin (36), Columbia, (21), Cornell (42), Harvard (50), Knox (13), Lake Forest (10), Marietta (10), Princeton (49), Ripon (10), Stanford (20), Wabash (22), Wellesley (22), Wesleyan (38), Williams (40), Yale (95). These were worked over by the chairman into complete tables like Table II. below, the first line of which reads, "Individual A did 18 per cent. of the total work required for the degree, in courses in ancient languages; 18 per cent. of it in courses in modern foreign languages; 13 per cent. of it in English; 5 per cent. of it in philosophy, 32 per cent. of it in history, economics, etc." These complete tables are too long to be printed, but they can not be summarized in lower terms. I give in Tables III. and IV. samples of the answers which may be got from them, using two arbitrary questions about the extent of specialization and superficiality.

TABLE II

Samples of the work done for the A.B. degree by individual students

		Latin, Greek, Sanskrit	French, German, Spanish, Italian	English	Philosophy, Psychology, Logic, Ethics, Anthropology	History, Economics, Government	Physics, Chemistry	Biological Sciences	Geology, Astronomy, Geography	Mathematics	Music, Fine Arts
Cases from Princeton	A	18	18	13	5	32	5		2	6	
	B	30	3	15	7	32	5			6	
	C	32	3	30	5	15	5			6	
	D	18	18	15	5	32	5			6	
	E	18	18	8	5	34	5			6	
	F	20	13	8	5	32	7		2	6	
	G	18	13	25	5	22	5			11	5
	H	18	13	15	5	36	5			6	
	I	23	8	6	5	39	5			6	
	J	20	10	15	12	30	5		2	6	2
Cases from Harvard	A		24	12	3		47	3		6	
	B		18	9		6	41		9	12	
	C	12	6	35	38	6					
	D		68	15		24					
	E	12	12	6	6	12	12			29	6
	F		18	27	15	47	6				6
	G[4]		12	18	15	21	12		3		29
	H	29	12	12	3	35	6		3	9	6
	I[5]		24	15		62		3			
	J[6]		18	18		24	12		18		6

[4] Also 12 architecture and 3 engineering.

[5] Also 6 education.

[6] Also 9 mining and 9 engineering.

TABLE III

	No. of Cases	No. Spending at least 50 Per Cent. of the Total Degree Requirement in: Language and Literature	History, Economics, Etc.	All Natural Science	Engineering	Medicine	Architecture	Law
I. Stanford,	20		1	4	5			(a)
Columbia,	21	5			2	2	1	
Cornell.	42	6	4	7		(a)		(a)
II. Harvard.	50	16	8	3	1			
III. Beloit, Knox, Marietta, Ripon and Wabash.	93	15	3					
IV. Bowdoin,	36	22		2				
Wesleyan,	38	20						
Williams,	40	15						
Wellesley,	22	12		1	See note (b)			
Yale,	95	25	3	1				
Princeton.	49	15						
Total.	506	151	19	18	7 or 7 (a)	2 5	1 1	0 11 by

(*a*) If the combination of the *hist. ec. gov.* group with law is counted as one group, and if the combination of science and medicine is counted as one group, we have added 11 cases (8 at Stanford, 3 at Cornell) of the former sort and 5 cases (at Cornell) of the latter sort of specialization.

(*b*) One case for music and art.

Of these cases of apparent scattering 34 are individuals each giving over three tenths of the total degree-requirement to history, economics, etc., and many of the others represent conceivably

TABLE IV

	Number of Cases	Number not Devoting 20 Per Cent. of the Total Degree Requirements to any one of the Following: (1) Ancient Languages. (2) Modern Foreign Languages. (3) English. (4) Philosophy, etc. (5) History. (6) Economics. (7) Government and Public Law. (8) Physics and Chemistry. (9) Biological Science (10) Other Natural Sciences. (11) Mathematics. (12) Art and Music. (13) Education. (14) Law. (15) Medicine. (16) Engineering. (17) Architecture	Per Cent.
I. Stanford	20	0	0
Columbia	21	0	0
Cornell	42	0	0
II. Harvard	50	6	12
III. Beloit, Knox Marietta Ripon and Wabash	93	16	17
IV. Bowdoin	36	0	0
Wesleyan	38	3	8
Williams	40	2	5
Wellesley	22	0	0
Yale	95	7	7½
Princeton	49	23	47
Total.	506	67	13

closely related work. This is the case, for example, with four of the six cases from Harvard.

For the Committee on Collegiate Education of Section L of the American Association.

EDWARD L. THORNDIKE,
Chairman

TEACHERS COLLEGE,
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THE SEXAGESIMAL SYSTEM AND THE DIVISION OF THE CIRCLE

THE division of the hour and the degree into 60 equal parts, called minutes, and the minute into 60 equal parts, called seconds, keeps fresh in our minds the fact that the ancient Babylonians used 60 as a base of numeration. Less than ten years ago all seemed to agree on the probable origin of this system. It was assumed that the ancient Babylonians supposed that there were only 360 days in a year and hence divided the circle so that one day corresponded to each division. In support of this hypothesis it was pointed out that the ancient Chinese divided the circle into 365¼ parts in their *Tcheou pei*, and that this work could not have been written before 213 B.C.; but at this early date the Chinese were already acquainted with the year of 365¼ days. From the assumption that the circle was divided into 360 equal parts before the origin of the sexagesimal system, and the fact that the radius of a circle can be applied exactly six times as a chord of the circumference, it was easy to account for the base 60.

In recent years this question has received considerable attention and many arguments have been advanced against the given hypothesis as regards the division of the circle. These arguments appear convincing, but it is not so easy to replace the old theory by one which is free from objections. In the third edition of his classic "Vorlesungen über Geschichte der Mathematik" (1907, volume I., page 37) Moritz Cantor accepts the hypothesis that the base 60 was selected as a consequence of the mingling in the Babylonian country of two ancient civilizations, one employing 10 and the other 6 as a base of numeration. In view of the difficulties which this hypothesis entails efforts have been made to find a more plausible one.

Professor Edmund H. Hoppe, Hamburg, Germany, has recently advanced such a hypothesis[1] and has given a large number of historical facts tending to its support. He assumes that the normal angle among the ancient Babylonians was an angle of an equilateral triangle and that it was observed at an early date that six such angles cover the entire area around a point. Hence the number 6 assumed great importance, being regarded to stand for completeness. The base 60 could then have easily resulted from a division of the normal angle into ten equal parts. After this base was established, alongside the much older base 10, the normal angle itself was divided into 60 equal parts and this led to the division of the circle into 360 equal parts.

Whether this hypothesis will be generally accepted remains to be seen. The fact that the

[1] *Archiv der Mathematik und Physik*, Vol. 15 (1910), p. 304.

ancient Babylonian wheel had six spokes while the ancient wheels in Egypt and Greece had only four tends to support the hypothesis that among the former an angle of 60° was regarded as normal while the right angle was regarded as normal among the latter. At any rate, the hypothesis advanced by Professor Hoppe tends to throw additional light on a question which relates to our daily experiences, but had not received a satisfactory answer.

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NOTES ON ENTOMOLOGY

The first volume of Mr. Kirkaldy's long-expected catalogue of the Hemiptera Heteroptera of the world has been issued, and is truly a great work. Indeed it is, if possible, too extensive and elaborate for ready reference. This volume[1] treats of the families known to us as Pentatomidæ, Scutelleridæ and Cydnidæ. The general plan is similar to that of the Lethierry and Severin Catalogue: the species of each genus are numbered, the localities at the right side of the page, and each reference includes the generic name used by each writer. Wherever known the food plants are given. In the introduction he has a classification of the order, and an exposition of the rules of nomenclature followed by him, which differ in several respects from those commonly adopted by entomologists.

The era of discovery of strange insects is not yet passed. Dr. Karl Jordan has described a new and truly remarkable genus of insects which was found in a sack on the wings of a Malayan bat.[2] He considers that it belongs to the Forficulidæ, but its resemblance to the common earwigs is extremely slight. It is a very flat insect, with a pair of small, curved, oval cerci; the pro- and mesothorax have a median suture; the head looks like that of a perlid larva, with a suture from eye to eye, the basal joint of the antennæ is very large and long. Dr. Jordan calls it *Arixenia esau*. He considers that it shows some relation to *Hemimerus*, and that it may possibly form a new suborder of Orthoptera. It might be useful to compare the insect with some of the Mallophaga, as a possible connecting link between them and some of the neuropteroid insects.

Dr. Alex. Schepotieff describes a new genus of primitive insects[3] which he calls *Protapteron indicum;* it comes from the Malabar coast. It is a small, slender form and has some resemblance to *Acerentomon*, but probably more allied to *Campodea*. It has four pairs of rudimentary feet on the basal abdominal segments, each two-jointed. There are no terminal cerci, and the antennæ are slender; there are five widely separated ocelli on each side of the head; each segment has only a dorsal and ventral plate, no other chitinized parts; the tarsi end in a single claw; and there are but two pairs of spiracles.

Dr. Albert Tullgren is the author of a most valuable paper on Swedish Aphidæ.[4] In this first part he treats of the Swedish Pemphiginæ. This subfamily he divides into six groups: Vacunina, Hormaphidina, Mindarina, Pemphigina, Schizoneurina and Anœciina. He gives a full description of each genus and species, and as much of the life history as is now known. He reviews the previous classifications of the subfamily Pemphiginæ, and presents considerable matter on the structure of the group. The numerous figures illustrate the essential structural characters, such as head, antennæ, cornicles and wings.

Dr. A. E. Shipley has given a valuable account of the insects affecting the red grouse in Scotland.[5] These are principally a biting louse, *Goniodes tetraonis*, the bird fly, *Ornithomyia lagopodis* and a dung-fly, *Scatophaga stercoraria*. The author has not found any connection between any of these parasites and

[1] "Catalogue of the Hemiptera Heteroptera," Vol. I., Cimicidæ, pp. 392, Berlin, December, 1909.

[2] *Novitates Zoologicæ*, Vol. 16, pp. 313–326, 1909, 3 plates.

[3] "Studien über niedere Insecten," *Zool. Jahrb., Abt. Syst.*, Vol. 28, pp. 121–135, 1909, 3 pls.

[4] "Aphidologische Studien," *Arkiv f. Zoologi*, Bd. V., No. 14, pp. 190, figs. 92, 1909.

[5] "The Ectoparasites of the Red Grouse (*Lagopus scoticus*)," *Proc. Zool. Soc. London*, 1909, pp. 309–334.

the disease that seriously affects grouse. The figures of the structure of some of these forms are extremely good, and particularly useful are those of the larvæ of the Scatophaga.

M. E. RABAUD has published a brief but interesting article on the habits of certain solitary wasps known as Pompilidæ.[6] He objects to the anthropomorphic interpretations frequently given of the habits of these insects. He notes much variation in the methods of capture and mutilation of prey, as well as in the interest they take in their work. He concludes that the sense which guides the insect in the selection of prey is sight and not smell.

THREE parts of the new "Coleopterorum Catalogus" of Dr. Schenkling have been issued: I., on the family Rhyssodidæ, 11 pp., is by R. Gestro; II., Nilionidæ, Othniidæ, Ægialitidæ, Petriidæ, Lagriidæ, 32 pp., is by F. Borchmann; III., Alleculidæ, 80 pp., is also by F. Borchmann. This name is used in place of the Cistelidæ; the interpretation of *Cistela* familiar to us being erroneous and now called *Gonodera* Muls. The catalogue is on the same plan as the famous catalogue of Gemminger and von Harold, but the derivations of the generic names are omitted.

To the ranks of the peculiar wingless Phoridæ Dr. Trägårdh adds a new genus[7] from South Africa. *Cryptopteromyia jeanssoni* has the wings reduced to mere scales, barely visible, the antennæ have a large bulbous base and a long hairy tip, the legs are long and strong and the body is but weakly chitinized.

THE manual of Indian insects recently published by H. Maxwell-Lefroy and F. M. Howlett[8] will undoubtedly be a most useful work for local students. It is a very bulky volume, and full of interest to those who are unfamiliar with the insects of India. The authors do not treat all Indian insects, those of the hills and the coasts being omitted. There is a long introduction telling of the structure and habits, collections in India, geographical divisions of India, relation of insects to man, etc. Each order is treated from the lowest up to the Rhynchota. Under each are directions for collecting the forms of each family, as well as habits, structure, life-history and number of species in India. As "interludes" are about eighteen chapters on general subjects scattered through the volume; such are: Cosmopolitan insects, deceptive coloring, galls, migration, song of insects, blood-sucking insects, aquatic insects, insects and flowers, etc. A number of figures are copied from other works, but most are original, and the plates are good, although, one fears, sometimes too highly colored. The economic importance of the various species is always considered, and most of the principal injurious forms are figured, often in all their stages.

NATHAN BANKS

[6] "Notes critiques sur les mœurs des Pompiles," *Bull. Sci. France, Belgique*, (7), XLIII., pp. 170–182, 1909.

[7] "Cryptopteromyia, eine neue Phoriden-Gattung mit reduzierten Flugeln aus Natal, nebst Bemerkungen über Thaumatoxena und Termitodeipnus," *Zool. Jahrb., Abt. Syst.*, Vol. 28, pp. 329–346, 1909, 1 pl., 16 figs.

[8] "Indian Insect Life: A Manual of the Insects of the Plains," Agric. Research Institute, Pusa, India, 1909, 786 pp., 535 figs., 83 pls., some colored.

THE BOTANICAL SOCIETY OF AMERICA

THE annual meeting of the Botanical Society of America was held in the Harvard Medical School, Boston, Mass., December 27–31, 1909, under the presidency of Professor Roland Thaxter, over fifty members being in attendance.

The officers for 1910 are:

President—Erwin F. Smith, Bureau of Plant Industry.

Vice-president—Louis R. Jones, University of Wisconsin.

Treasurer—Arthur Hollick, New York Botanical Garden.

Secretary—George T. Moore, Missouri Botanical Garden.

Councilors—William Trelease, Missouri Botanical Garden; F. E. Clements, University of Minnesota; C. L. Sheer, Bureau of Plant Industry.

The following eight botanists were elected associate members of the society: John Hendley Barnhart, New York Botanical Garden; Edward W. Berry, Johns Hopkins University; Mintin Asbury Chrysler, University of Maine; Reginald R. Gates, Missouri Botanical Garden; Otto Emery Jennings, Carnegie Museum; Aven Nelson, University of

Wyoming; Winthrop J. V. Osterhout, Harvard University; Robert Boyd Thompson, University of Toronto; and the following members were elected to full membership: C. E. Allen, University of Wisconsin; A. F. Blakeslee, Storrs Agricultural College; E. J. Durand, Cornell University; J. M. Greenman, Field Museum of Natural History, and Shigeo Yamanouchi, University of Chicago.

Special papers given by invitation of the council were:

"The Nature of Physiological Response," by C. R. Barnes.

"The Place of Plant Responses in the Categories of Sensitive Reactions," by F. C. Newcombe.

"The Distribution of the Vascular Plants of the Gaspé Peninsula, Quebec," by M. L. Fernald.

"A Consideration of the Species Plantarum of Linnæus as a Basis for the Starting Point of the Nomenclature of Cryptogams," by W. G. Farlow.

The subject for the customary symposium was "Nuclear Phenomena of Sexual Reproduction in Thallophytes and Spermatophytes," and was participated in by B. M. Davis, who discussed the subject from the standpoint of the algæ; R. A. Harper, who considered the fungi; C. J. Chamberlain, for gymnosperms, and D. M. Mottier, for angiosperms.

It is expected that all of these papers will be published in *The American Naturalist* and reprints distributed to the members of the society.

Following are abstracts of the papers presented at the two scientific sessions held simultaneously on the afternoon of December 29:

Botanical Collecting in the Yukon Valley: A. S. HITCHCOCK, U. S. Department of Agriculture. By title.

Some Evaporation Experiments in Relation to Excessive Transpiration: K. M. WIEGAND, Wellesley College.

In order to determine, if possible, the comparative value to the plant of hairy and cutinized coverings, a series of evaporation experiments was made in which cotton or wax spread over an evaporating surface of saturated blotting paper were substituted for a hairy leaf or a cutinized leaf, respectively. Comparative readings of the loss of water from the variously treated blotting papers in still air and in wind were made, with the following results: the evaporation was retarded much more by the wax than by the hair; the efficiency of the hair, however, was much greater in wind than in the quiet, and even very thin hairy coverings produced a noticeable retarding effect in wind. In sunshine the retarding effect was also marked. Plants might therefore be supposed to make use of waxy coverings when transpiration is to be retarded at all times, and hairy coverings when it is to be retarded only if exposed to strong dry winds and sunshine.

The Responses of the Guayule, Parthenium argentatum Gray to Irrigation: FRANCIS E. LLOYD, Alabama Polytechnic Institute.

A brief summary of the more important results of a study of the guayule, *Parthenium argentatum* Gray, under irrigation at Cedros, Mexico, for a period of two years, touching (1) the rate of growth, (2) the anatomical changes which ensue and (3) the rate and amount of rubber secretion together with a discussion of centers of secretion.

Guayule under irrigation makes an annual gr wth up to 25–30 cm. stem length, which appears to be approximately the maximum rhythmic response. Field plants in the same region make an average growth of 3 cm. Guayule responds readily, therefore, to irrigation, making plants of two to three pounds in weight from closely pollarded stocks.

At the close of two seasons' growth in August, 1908, irrigated plants showed only minute quantities of rubber. The same plants in the following April showed a large though not a maximum amount. Still more was found to occur in plants which had received less water of irrigation, this in growths of 1908 and 1909, in October, 1909. The conclusion is arrived at that, though the rate of secretion is slower in more rapidly grown plants, it may, after drought, approach fairly closely, if not entirely, to the maximum. The behavior under irrigation may be regarded as the behavior in feral plants with an exaggerated time element. In view of the total amount of growth, however, the conclusion that a total amount of secretion in an irrigated plant is greater in the long run than in a field plant is justified.

It is further shown that marked anatomical changes result from irrigation, chiefly affecting the volume of the cortex which is reduced under irrigation. The volume of the medullary rays is also much less, and sclerosis overtakes the medullary rays cells and sometimes the pith cells. The effect upon the amount of rubber is apparent in view of its distribution in these tissues, and not in the xylem and phloem (the parenchyma of these excepted).

The rubber is secreted from the secreting cells

of the resin canals as centers. The resin is not secreted within these cells and this supports Tschirch's view of resin secretion.

The paper was illustrated by means of photomicrographs and diagrams.

The Origin of Natural Parks: FREDERIC E. CLEMENTS, University of Minnesota.

During the past summer a special study was made of the natural openings typical of many of the mountain forests of Colorado. These so-called parks range in size from hundreds of square miles, as in South Park and San Luis Park, to a few acres. They occur in practically every one of the forest formations, and are themselves swamp, grassland or chaparral of varying structure. This was clearly found to be due to the fact that parks are only stages in successions, the ultimate stage of which is the surrounding forest in the great majority of cases. Fire was found to be the most frequent cause of the successions that produce parks, while some the largest and most striking are due to the filling of lakes with silt and plant remains. Parks also follow the filling up of canyons by sedimentation, while temperature and migration are more or less frequent causes of parks.

The Intensity of Alpine Light: FREDERIC E. CLEMENTS and FREDERIC K. BUTTERS, University of Minnesota.

Readings were made during the past summer in the Selkirk Mountains, on Mt. Rainier, and in the Rocky Mountains of Colorado in accordance with the same general plan. These were designed to test the series of results obtained in Colorado for a number of years, and to determine whether mountain regions with higher humidity would reveal greater absorption. The readings made in the two regions are in close, if not complete, agreement, and confirm the original conclusions that alpine light is little if at all stronger than the light at lower altitudes, and that it can not be an efficient cause of alpine dwarfing.

The Morphology of a Remarkable New Gymnospermous Genus: E. C. JEFFREY, Harvard University.

The genus is characterized by the possession of the wood structure found in the araucarian genera *Araucaria* and *Agathis*. It differs, however, strikingly from these genera in the possession of short shoots, which resemble rather those of *Ginkgo* than those of *Pinus*. The short shoot, or brachyblasts, persisted through many years and their bases, embedded in the secondary wood of the main axis, in spite of their obvious perennial character, present only a single zone of annual growth. The short shoots were axillary to deciduous leaves, the traces of which, unlike those of *Agathis*, *Araucaria* and allied extinct genera, do not persist in the secondary wood. The genus is named *Woodworthia*. It constitutes one more link between the abietineous and araucarian conifers, which it is now apparent are connected by annectent transitional forms.

Color Inheritance in Lychnis dioica: GEORGE HARRISON SHULL, Station for Experimental Evolution, Carnegie Institution.

Several years ago I showed that the purple color of *Lychnis dioica* is a typical Mendelian dominant character. It has since been found to present several distinct grades of color, not noted at first, but now shown to be due to distinct Mendelian unit-characters. Most noteworthy of these is a light bluish-purple tint due to basic anthocyan, which is *hypostatic* to the corresponding acid or reddish-purple anthocyan. Blue anthocyan has generally been found to be *epistatic* to red in other cases.

Notes on the Behavior of Certain Hybrids of Œnothera in the First Generation: BRADLEY MOORE DAVIS, Cambridge, Mass.

A demonstration and discussion of material illustrating the characteristics in the first generation of the following hybrids of *Œnothera:* (1) *gigas* $\times$ *Lamarckiana*, (2) *muricata* $\times$ *gigas*, (3) *muricata* $\times$ *grandiflora*, (4) *grandiflora* $\times$ *biennis*, (5) *biennis* $\times$ *grandiflora*.

The characters of the parents, as presented in each cross, were so blended that as regards the measurements of parts, habit, texture of foliage, etc., the average for each set of hybrids would probably present a fair mean between the parents concerned. There was, however, a wide range of variation in the resemblance of the hybrids to one or the other of the parents.

No character of either parent was discovered which appeared as dominant in these hybrids of the F_1 generation, after the manner which has been described for certain forms (*e. g.*, *Pisum*) that illustrate most conspicuously Mendelian dominance in the first generation.

Some of the hybrids of each cross presented a greater resemblance to one parent and some to the other, and the forms could therefore be arranged in two groups (twin hybrids) in one of which the maternal characters were most evident and in the other the paternal. There was no clear evidence

that the hybrids of these cultures carried in marked preponderance the paternal characters (patroclinous), or, on the other hand, that maternal characters were more prominent. The range of variation among the hybrids was too great to permit of such conclusions.

The Effect of Some Toxic Solutions on Mitosis in Vicia faba: W. W. Stockberger, Bureau of Plant Industry, U. S. Department of Agriculture.

Root-tips of *Vicia faba* were exposed for varying lengths of time to the action of very dilute and to more concentrated solutions of copper sulphate, phenol and strychnine. As a result the achromatic figure was frequently enlarged and the spindle seemed to increase in size. Later the spindle fibers were more seriously affected, becoming disorganized, while numerous vacuoles formed in the cytoplasm. Mitosis was interrupted, but without deformation of the chromatic figure. Formation of the cell plate was often prevented, following which, however, complete reconstitution of the nuclei was not observed. Neither the binucleate cells nor the nuclear fusions of some authors occurred in the material studied. No amitosis was observed and there was no evidence that it is produced by these solutions. The interpretation as departures from the normal due to the toxic solution of the numerous aberrant forms which occurred in the toxicated material was negatived by the occurrence of similar forms in the controls. Material grown in distilled water was affected in much the same manner as that in the toxic solutions. When toxic salts were used in great dilutions it became very difficult to distinguish between their effect and the physical action of the solution in which they were dissolved.

Nuclear Organization in the Conidia of Sphærotheca: R. H. Harper, University of Wisconsin.

Polarized nuclei with a central body in permanent connection with the nuclear chromatin and similar in all respects to those described for the ascocarp and mycelium of *Phyllactinia* are found also in all stages of the development of the conidia of the *Sphærotheca* on *Bidens*.

The resting stages are of especial importance, as it is at this time that the connection of centrosomes and chromatin is of especial significance as giving evidence of the permanence of the chromosomes as definitely organized bodies.

The center in these conidial nuclei is disk-shaped and lies on the outside of the nuclear membrane. Cases in which the center is pulled into the cavity of the nucleus are found, but are plainly artefacts due to fixation, as are probably also the similar cases figured by Maire and Guilliermond. The chromatin in the resting condition may appear almost homogeneous and evenly distributed in the nuclear cavities, but even here a few strands show the special connection of the mass with the central body.

In the prophases the granular material becomes gradually aggregated in strands which show a definite orientation toward the central body. The gradual differentiation of a spirem can be traced in all its stages and the heavy strands finally formed are always attached at one end to the center. Throughout the resting stage and prophases organic connection is maintained between the central body and chromatin and thus a mechanism is provided for the maintenance of the individuality of the chromosomes through the processes of splitting in nuclear division and of fusion in pairs side by side in fertilization. The spindle formation follows the usual type which I have described for the nuclei of the ascus.

Nuclear Phenomena in Lachnea scutellata: William H. Brown, Johns Hopkins University. By invitation.

The asci of *Lachnea scutellata* arise from a one-celled ascogonium at the base of the fruit-body. No antheridium has been observed and no fusion or pairing of nuclei in the ascogonium or young ascogenous hyphæ. The nuclei of the vegetative hyphæ, ascogonium and ascogenous hyphæ show five chromosomes. During prophase these chromosomes may be close together and resemble a second nucleolus. In reorganizing, the daughter-nuclei are often so close together as to appear to be fusing. These two phenomena may have been mistaken by some for fusing nuclei.

The usual hooks are formed at the ends of the ascogenous hyphæ. The two nuclei of the penultimate cell may fuse and give rise to the nucleus of an ascus, or they may not, in which case a second hook is formed. An opening is formed between the ultimate and penultimate cells and the nucleus of the penultimate migrates into the ultimate, which may then form a second ascus or another hook. This process may be repeated many times.

The first division of the nucleus of the ascus is the reducing division and shows the usual heterotypic prophases. It is the only division that shows the diploid number of chromosomes.

The spore wall is laid down near the outer

limits of the recurved spindle fibers, but it is not formed out of them.

Two Trunk Diseases of the Willow Oak (*Quercus phellos*): HERMANN VON SCHRENK, St. Louis, Mo.

The willow oak is attacked by two polyporoid fungi which destroy the heart wood. No such diseases have hitherto been described, and the discovery at this time was due to the unusual hurricane which destroyed vast numbers of trees in the southern states during the past fall.

A description of the cause of the disease, the manner in which the trees are attacked and destroyed and the distribution form the chief topics of the paper.

A Trunk Disease of the Osage Orange (*Toxylon pomiferum*): HERMANN VON SCHRENK, St. Louis, Mo.

The osage orange has hitherto been considered as practically immune from fungus diseases. The wood of this tree is very indestructible when used for structural purposes, and so far as known, no fungus ever attacks the heart wood. The present paper describes the finding of fungus disease of the heart wood, which occurs in living trees. This disease is of particular interest in view of the geologic age of the genus, and furthermore in view of the fact that this is the first case of a trunk disease of this species.

Studies on the Toxicology of Diplodia zeæ: HOWARD S. REED, Agricultural Experiment Station, Blackburg, Virginia.

A brief examination of the literature dealing with the etiology of pellagra shows great diversity of opinion as to the identity of the fungi held responsible for the deleterious property of the affected maize. In this connection attention is called to the recent spread in this country of *Diplodia zeæ*. This fungus became conspicuous as the cause of wide-spread injury to maize almost simultaneously with the appearance of pellagra. It is also present in European countries where pellagra is found. Recent studies have shown that the fungus lives parasitically upon the growing maize as well as saprophytically upon the mature grain.

The author has in progress chemical and physiological experiments upon the properties of maize infected with *Diplodia*. The chemical substances isolated to date have similarity to those isolated by Lombroso. Physiological experiments have shown that the infected maize is toxic to small animals.

Some Notes on Sclerotinia fructigena: JAMES B. POLLOCK, University of Michigan.

Aderhold suggested in 1905 that the species of *Sclerotinia* commonly attacking stone fruits in the United States was *S. cinerea* and not *S. fructigena*, as had been assumed. He based his opinion on several facts: the color of the tufts of macronidia on the attacked fruits, the size of the conidia, the occurrence in Europe of *S. cinerea* chiefly on stone fruits and of *S. fructigena* on pome fruits, and lastly on the size of asci and ascospores which Norton described in 1902.

Studies were made on material collected at Ann Arbor and Lansing, Michigan, and this was compared with the reports of various workers in Europe and the United States. The conclusions reached are:

Norton's measurements for asci and ascospores are probably incorrect. The apothecia found in Michigan as well as in other parts of the United States agree very closely with those of *Sclerotinia fructigena* as found in Europe. There is a wide range in the size of the macroconidia, especially on artificial media, and as found in nature they are generally smaller in the United States than in Europe.

In the United States the species occurs more commonly on stone fruits, and in Europe more commonly on pome fruits.

Sclerotinia fructicola (Winter) Rehm is in all probability the same species as *Sclerotinia fructigena* (Pers.) Norton.

The Present Status of the Cytology of the Rusts: E. W. OLIVE, South Dakota State College of Agriculture and Mechanic Arts.

Only fourteen species of rusts have contributed so far toward a solution of the problem as to the sexual cell fusions in this group of fungi. Of this number, nine were æcial forms, five telial. Blackman himself leaves his four telial species in a doubtful condition; and the writer's work on the development of the æcidium cup forms casts doubt on the interpretation of both Christman and Blackman as to the four cup forms which they studied; thus leaving only six species in a presumably stable condition as to the method of sexual union. Of these six species, three—*Gymnoconia interstitialis, Phragmidium speciosum* and *Phragmidium violaceum*, belong to the diffuse cæoma type of æcidium; two—*Phragmidium potentillæ-canadensis* and *Triphragmium ulmariæ*, to the primary uredo type, and one—*Puccinia transformans*, to the micro-puccinia type.

To this list the writer is now able to add three of the cup-æcidium type of rusts as showing sexual fusions. Further, a large proportion of the fifty species of æcidium cups under investigation have been found to show a multinucleated stage in their development; this stage following, in the three species above mentioned, the sexual fusions. A contribution has been also made in this investigation toward the solution of the problem as to the origin and function of the peridium, it being found to arise in the manner described by Rosen and Richards. Some observations seem to show, moreover, that the peridial cells exert a sort of digestive function, in addition to acting as a protection to the expanding æcidial mass.

Cultures of Uredineæ in 1909: J. C. ARTHUR, Purdue University.

The paper covers a report in detail of the work in growing plant rusts during the year 1909, this being the eleventh year that the work has been carried on. It is almost entirely devoted to the heterœcious species of grass, sedge and cedar forms. One new species of the last has been separated, having æcia on *Amelanchier* leaves of the type of *Rœstelia cornuta* and telia on the branches of red cedar. Only one new combination was worked out among the grass rusts, and none among the sedge rusts, but much additional information is reported on species previously cultivated.

GEORGE T. MOORE,
Secretary

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 676th meeting was held on February 12, 1910, President Woodward in the chair. Two papers were read.

The Solar Constant of Radiation: C. G. ABBOT, of the Astrophysical Observatory of the Smithsonian Institution.

The speaker stated that when in 1903 determinations of the solar constant of radiation were begun by the Smithsonian Astrophysical Observatory, values ranging from Pouillet's 1.76 to Angström's (withdrawn) value of 4.1 calories were quoted in the best text-books, generally with a preference for Langley's value 3.0 calories. The discrepancy existed (1) because no international standard scale of pyrheliometry had been established, so that measurements of different observers might differ by ten or even twenty per cent., according to what pyrheliometer they employed; (2) because, since no spectrum energy measurements had been made except by Langley (and his wrongly reduced), the observations made were incapable of yielding the correction for loss in air, and hence recourse was had to purely empirical and untrustworthy formulæ of extrapolation.

At Washington, Mt. Wilson and Mt. Whitney (sea-level, one mile and three miles elevation) complete spectro-bolometric and pyrheliometric measurements have been made on several hundred different days from 1903 to 1909. Simultaneous determinations at Washington and Mt. Wilson in 1905 and 1906 agreed within the probable error of the Washington observations. Simultaneous observations at Mt. Wilson and Mt. Whitney in 1909 agreed within 0.5 per cent. Hence it is believed that the formula of Bouger for the atmospheric extinction of monochromatic rays (such as the bolometer observes) is not only theoretically well grounded, but experimentally verified, for otherwise the solar constant values obtained by its aid from such different atmospheric levels could hardly agree.

Three different copies of Abbot's water-flow standard pyrheliometer have been tried on Mt. Wilson with closely agreeing results. In this instrument the measurements are checked by observing known quantities of heat electrically introduced. The scale of the instrument appears to be about three per cent. above that of the new Angström pyrheliometers, but careful redeterminations of the constants of the Abbot pyrheliometers are now being made by Mr. Aldrich, and these may alter the scale by as much as one per cent. When verified, four silver disk secondary pyrheliometers of the Smithsonian Institution will be calibrated to this scale and sent abroad to promote a uniform international system of pyrheliometry.

Provisionally the mean value of the solar constant may be given as 1.92 calories per square centimeter per minute.

Mr. Abbot also spoke briefly of the apparent variations of the solar constant of radiation.

The Nitrogen Thermometer from Zinc to Palladium: A. L. DAY and R. B. SOSMAN, of the Geophysical Laboratory of the Carnegie Institution of Washington. Presented by R. B. Sosman.

The preliminary work of Day and Clement at the geophysical laboratory developed the apparatus for accurate measurement of temperatures with the nitrogen thermometer. It consisted of

the following essential parts: (1) a gas-tight platin-iridium bulb of constant volume; (2) a platinum resistance furnace, arranged to give a uniform temperature over the bulb; (3) a gas-tight furnace jacket, water cooled, arranged to provide the same pressure outside as inside; (4) an open mercury manometer, with the minimum possible unheated volume between bulb and manometer.

In the present work, an alloy of 80 Pt, 20 Rh, has been substituted for the Pt-Ir in order to avoid the error due to contamination of the thermoelements by Ir.

All of the errors and corrections have been examined and their amount, as far as possible, experimentally determined. The greatest error to which the present gas thermometer is subject is the lack of uniformity in temperature in an air bath; the error of next importance is that in the transfer by means of the thermoelement.

The expansion coefficient of the bulb material was determined from 300° to 1400°. Between these limits the expansion is expressed by the formula $10^6\beta = 8.79 + 0.00161\,t$.

The temperatures, on the nitrogen scale, of the melting points of eight metals and two silicates between 400° and 1550° were determined with the ten per cent. Pt-Rh thermoelement as intermediary between the nitrogen thermometer and the fixed points. The metals were all analyzed by Dr. E. T. Allen. Two initial pressures were used, about 220 and 350 mm.; no systematic difference could be observed between the values of t derived from these two pressures. The final results are as follows:

Zinc	in air	in graphite	418.2 ± 0.3
Antimony	in CO	in graphite	629.2 ± 0.5
Silver	in CO	in graphite	960.0 ± 0.7
Gold	in CO	in graphite	1062.4 ± 0.8
Copper	in CO	in graphite	1082.6 ± 0.8
Diopside	in air	in platinum	1391.2 ± 1.5
Nickel	in N	in magnesia	1452.3 ± 2.0
Cobalt	in H	in magnesia	1489.8 ± 2.0
Palladium	in air	in magnesia	1549.2 ± 2.0
Anorthite	in air	in platinum	1549.5 ± 2.0

In addition, the melting temperatures of cadmium (320°) and of aluminum (658°) were obtained, but these metals were not used as standard points.

By adding the optically determined difference of 206° to the palladium point obtained above, the melting point of platinum is found to be 1755°, which is not more than 5° in error.

The curve of the 80 Pt 10 Rh thermoelement was found to deviate considerably from the very generally used parabola passing through zinc, antimony, silver and copper, and extrapolated above the latter temperature. The low value of 1710° for the melting point of platinum obtained by this extrapolation is therefore explained.

There is a disagreement of from 1.0° to 1.3° between the present scale, at its lower end, and the scale hitherto in use for calibrating the platinum resistance thermometer. The cause of the difference is not known. Between 500° and 1100° the present scale is about 1.5° lower than the Reichsanstalt scale in general use. Above 1100°, the temperatures of palladium and platinum obtained by Holborn and Valentiner are shown to be too high, and the new values are about those expected from previous estimates.

R. L. FARIS,
Secretary

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

A REGULAR meeting of this section was held at the American Museum of Natural History, December 13, 1909, Chairman Frank M. Chapman presiding. The following papers were read:

Notes of an Ornithologist in South America: Mr. C. WILLIAM BEEBE.

The speaker gave an account of three expeditions to the forest regions of British Guiana, South America, for the purpose of studying and collecting the rarer birds of that locality. Many admirable photographs were shown of rare birds, among them the first photographs ever taken of the hoctyui, the female being shown in her characteristic crouching attitude near the nest and a flock of eleven in one tree. Incidentally some remarkable photographs of mammals were obtained, among them, one showing six capybaras and several young on a river bank taken by Dr. Hiram Bingham, and one of a manatee swimming with mouth and nostrils just above the water.

The Influence of the Nervous System in Regeneration: Mr. A. J. GOLDFARB.

The speaker briefly reviewed the suggestions that had heretofore been made to account for the fact that some animals were able to replace a missing organ, while others were unable to do so. A concise summary was then given of the experimental data that supported the conclusion that regeneration was dependent upon a stimulus exerted by or through the central nervous system.

The speaker then described the experiments that he had made during the last several years, upon

five widely different kinds of animals. In each animal the most painstaking care was taken to make certain that *all* motor or sensory or both of these cells, innervating a given organ had been completely destroyed. In spite of the total removal of the nerve stimuli the missing organ was regenerated in every case. Thus the frog tadpole regenerated its tail, the adult newt *D. viridescens* regenerated its tail and leg, the earthworm its head, the starfish its arm, and the planarian *D. lacteum* the anterior third of its body. It was pointed out that the agreement among these very different organisms probably signified that animals as a whole, whether during their larval or during their adult stage of development, regenerate their missing organs independently of a central nerve stimulus.

At the annual dinner and business meeting of the New York Academy of Sciences, held at the Hotel Endicott, New York City, December 20, 1909, the following officers were elected for the Section of Biology for 1910:

Chairman—Professor Charles B. Davenport.

Secretary—Dr. L. Hussakof.

A REGULAR meeting of this section was held at the American Museum of Natural History, January 10, 1910. In the absence of Chairman Chas. B. Davenport, Mr. Roy W. Miner presided. The following papers were read:

Some Remarks on Myriapods: Mr. ROY W. MINER.

The speaker gave an illustrated talk on the myriapods, dwelling on their classification, evolution and morphology. Handlirsch's theory of the derivation of the Crustacea, Myriapoda and Hexapoda from pro-annelidan stock through trilobite forms was discussed in some detail, special attention being given to the evolution of the ancestral insects (Paleodictyoptera) from the trilobites, and their relation to the primitive myriapod stock. All the more typical myriapods were illustrated and their striking anatomical features commented on.

The Ultra-microscope and its Application to the Study of Microscopically Invisible Particles: Dr. MAX MORSE.

The ultra-microscope was devised by Zsigmondy and Siedentopf on the principle determined by Tyndall, that if a solution is examined under the microscope by means of horizontal illumination and not by light transmitted through it by the substage mirror, the particles within the solution polarize the light and thereby render them visible as scintillations against a dark background. By means of this instrument, solutions which appear perfectly homogeneous by means of the ordinary microscope are shown to be composed of particles in suspension. Bodies approaching the dimensions of molecules can be made visible.

Colloidal solutions have been analyzed by means of the ultra-microscope and shown to be suspensions of particles in a homogeneous medium. Thus, colloidal gold and platinum are resolved into such *pseudo*-solutions. Albumens fall under this heading and studies of their nature have shown that they are not homogeneous in solution, but are rather fine suspensions.

The ultra-microscope as first devised has been modified so as to be adapted to the study of living bacteria. The substage condenser of a microscope is replaced by one where the lens, in place of being biconvex, is parabolic and a stop is placed in the center of the disc so that no *direct* rays pass to the eye, but only those that have been polarized by the bacteria which receive the rays that are sent through them horizontally. The bacteria flora of teeth was shown. Spirochætes and rod forms are seen and their locomotor organs are made visible.

Notes on the Restorations of the Cretaceous Birds Hesperornis and Baptornis: Mr. BARNUM BROWN.

A few brief notes from a forthcoming paper were presented. The anatomy of *Hesperornis* as known from described material was discussed and compared with a skeleton recently mounted in the American Museum. In this specimen for the first time a complete tail is known. The swimming pose here chosen is accepted as the one that best represents the aquatic habits of the bird and more nearly conforms to the structure of the limbs. The peculiar arrangements of the palate bones in *Hesperornis* and the contemporary *Baptornis* were shown to constitute characters that distinguish them from all known birds.

Two new specimens have made possible a paper restoration of *Baptornis* which in some characters is more primitive than *Hesperornis*. The striking features are a complete fibula, heretofore known only in *Archæopteryx* and a very long tail of which fourteen vertebræ are preserved. There were at least sixteen. The palate bones are like those of *Hesperornis*.

L. HUSSAKOF,
Secretary

AMERICAN MUSEUM OF
NATURAL HISTORY

SCIENCE

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THE PROBLEM OF THE ASSISTANT PROFESSOR.* II

We now pass to the second division of our subject, which, because of its somewhat broader aspects, requires a slightly different mode of presentation.

Questions 18, 19 and 20 were prepared with a view to elicit information upon the extent of academic freedom and of participation in the solution of university problems, enjoyed by assistant professors.

Says President Eliot in his most valuable and suggestive "University Administration":

For determining the educational policy of a seat of learning, the faculties are the most important bodies in the entire institution. . . . It devolves upon the faculties . . . to discern, recommend and carry out the educational policies of the institution. . . . Membership in a faculty should therefore be limited to professors, associate professors and assistant professors, and to those instructors who have received appointments without limit of time. . . . It is of the utmost importance that every faculty contain enough young men to bring forward in debate the views and feelings of the recent college generation. To have its administration fall chiefly into the hands of elderly men is a grave misfortune for any institution. There is always good work that veterans who retain their physical and mental alertness can do; but the control of a university's policy should not be confided to them alone. . . . By the vitality, inventiveness and enterprise of its faculty, it is safe to judge any institution of learning.

President Hyde, in his refreshing paper on "Personality and College Professors,"[6] adds to this:

* A paper prepared for the eleventh annual conference of the Association of American Universities, on behalf of Leland Stanford Junior University, by Professor Guido Hugo Marx and presented by Professor Charles H. Huberich.

[6] *The Outlook,* August 21, 1909, pp. 931–7.

Because, in an experience of twenty-four years, I have seen 95 per cent. of all administrative reforms advocated and accomplished by men under thirty-five, I heartly endorse President Eliot's principles of juniority as the distinguishing mark of a progressive as distinct from a stagnant institution.

The three university presidents, of those not now in service, who have exerted the greatest formative influence upon the modern American university, are Presidents Eliot, Gilman and White. The first took up his presidential duties at Harvard at the age of 35; the second at California at the age of 41 and at Johns Hopkins at 46; the third at Cornell at 35.

In view of the foregoing facts, the extent of participation by men of 37 in the direction and control of educational policies of the several universities, disclosed by the following typical answers, is enlightening. The replies were formulated from a few more than a hundred received from twenty institutions. Unless otherwise stated, three or more answers were received from the institution. A composite reply is arranged, to give the range of replies from each individual institution, as representing the point of view of the assistant professor.

Query 18*a* was: "What are your opinions concerning the status of the assistant professorship in sharing in the determination of general policies of your institution?"

The replies:

1. "The policies of the university are really shaped by the president." "Assistant professors have a vote in the council, just as the full and associate professors have. They do not often initiate movements or policies, but have the full right of discussion, voting, etc." "Nothing more to be desired."

2. "Assistant professor has status a little above janitor." (Less than three replies.)

3. "Fairly satisfactory here." "They should have a full share in administrative and departmental policy, because unless they have such a share, with its responsibilities and the recognition resulting from it, the better part of their experience, idealism and progressiveness is wasted."

4. "Fairly satisfactory." (Less than three replies.)

5. "Satisfactory." "They have as much influence, nearly, as full professors." "They have little share in the determination of general policies."

6. "There are no differences [between assistant and full professors] in these matters." (Less than three replies.)

7. "Very little direct influence at present." "He has a seat and voice in his college faculty, but not in the general university senate." "Not much share."

8. "Have a vote in faculty meetings." "Share but slightly in the determination of general policies." "Only through suggestions to the head of the department." "General policies are determined largely in meetings of the faculty heads of departments."

9. "No voice whatever in determining institutional policies." "At present assistant professors have no share." "None."

10. "Very little." "Mostly in hands of the deans." "Think assistant professors little less powerful than full professor. Believe a suggestion from either would be considered by the administration with equal care." (Note inference to be drawn from this last sentence. A side-light is thrown by the volunteered statement of one who left this institution for a larger one: "Conditions in this respect were highly unsatisfactory at ——————.")

11. "Not being member of council, can not answer." "Believe most assistant professors to be of ripe enough age and sober-minded enough to give some good ideas." "No discrimination save in excluding new assistant professors from council for three years." "It is all it should be."

12. "Almost no share." "Has little influence; mostly done by older men." "Mostly in hands of heads of departments. Here the elder statesmen are in control."

13. "As a rule, given altogether too little say." "Is given no say in policy of institution." "Should be heard in regard to such questions." "Has a vote in all faculty actions." "When a division is called for in faculty meeting, professors have two votes, assistant professors one vote and instructors no vote."

14. "Satisfactory in all respects. Depends entirely on his individual ability." "As to general policies, all assistant professors have a vote, as well as professors and deans, in the council."

15. "Left to heads of departments." "Incidental [share] only." "Should be given full vote on questions pertaining to institution policy." "The assistant professors are members of the general faculties in which they teach."

16. "Should have a vote in all matters submitted to members of the institution." "I am in the council which determines the policy. Am elected by confrères below rank of clinical professor. Other assistant professors are members of the 'faculty,' which is without power of initiative." (Less than three replies.)

17. "My share is as large as that of the average full professor." "In my case I can see no difference between assistant and full professors in this respect." "We enjoy all the privileges of full professors, but receive smaller salaries. It seems to me that is about the only distinction here."

18. "Depends upon personality and attainments of the assistant professor." "They have a great deal of influence here with us, and vote in faculty and committee meetings just as full professors do." "Perfectly satisfactory."

19. "An appropriate share." "Have votes on all questions in faculty meetings and serve on many important committees."

20. "No influence." "General policies are determined entirely by the full professors."

The foregoing replies show considerable range of institutional policy. Taken with their contexts (necessarily omitted here) they also disclose a prevailing conception of a faculty, as a body scarcely so important and influential in its functions as the ideal quoted from President Eliot at the beginning of this section. In this light, such apparently discrepant answers as, for instance, those grouped under institution 5, fall into harmony, and so interpreted would mean that the faculty, as a whole, bears but small part in shaping policies, but in that part the assistant professors have nearly the influence of the full professors.

Our next query is directed at one of the most sensitive points in the present-day university organizations—the status of the assistant professor in sharing in the determination of departmental policy, curriculum and assignment of courses. The replies are grouped by institutions, although, under the prevailing system of departmental organization with permanent heads possessing ill-defined powers, it is natural to expect greater variations within the individual institutions, according to the interpretation of their duties by the various department heads.

Query 18*b*, replies:

1. "The head has absolute power." "According to the disposition of the head of the department." "Departments vary in this university. In some it is done by conference and general meetings. In some (——— *e. g.*) we are called upon occasionally for suggestions in writing, all decisions resting with the head of the department. We have had about three department meetings in fifteen years. We get in writing our assignment of courses and hours from the head of the department." "Departmental policy (——— department) very democratic. Majority of questions determined by vote of entire department. Individual wishes consulted wherever feasible."

2. "Is consulted about only his own courses." (Less than three replies.)

3. "Fairly satisfactory."

4. "Satisfactory in my department." "Very pleasant relations with the head of department." (Less than three replies.)

5. "Considerable, but (in general) insufficient share." "They have little to do with it. The system of departmental headship is to blame for this. This is the most detrimental arrangement within our universities at present." "Unsatisfactory. Too much power is centered in the head of the department. The assistant professor given little chance to influence departmental policy." "Have been practically full professor except in salary."

6. "No difference [between assistant and full professors] in these matters at ———." "Should have an advisory capacity, but determination of course of conduct should be in hands of heads of departments." (Less than three replies.)

7. "Not much share." "He is usually con-

sulted, but there is no formal obligation to consult him." "In our department, the assistant professor is an important factor in all departmental policies, and helps form these policies." "A large share."

8. "In departmental policy more attention is paid to his suggestions [than in general policy]." "My opinions are given careful consideration." "Have great range of liberty. The professor is one of the best in this regard that I ever knew." "Departmental policies in the ——— department at present determined by the two heads. Have poor opinion of any two-headed arrangement." "Such things should be determined by conference of all members of the departmental staff."

9. "Good in some departments, poor in others." "Share to a very limited extent." "Am freely consulted by the head of the department relative to all matters of departmental policy." "Should have a vital part." "Should be consulted."

10. "No share." "Voted upon in general faculty meetings." "An equal voice, almost, as to departmental affairs. Great freedom in expression of opinions, etc." "We are very democratic in the department." "Should be consulted, and, I believe, is here."

11. "Depends upon the department." "Not given enough responsibility to give them an active interest in the administrative work of the institution, or to encourage loyalty to it." "Should have voice in planning work and getting just recognition for what they do." "Suggestions have been received for all they were believed to be worth—perhaps not all I thought." "I have as much voice in these matters as if I were a full professor." "Well off in this respect." "All it should be." "In ——— department conditions practically ideal."

12. "Its influence felt a little, but not much." "Very little; not consulted at all." "Influence in proportion to favor enjoyed in eyes of head of department."

13. "Shares none too much." "Very little say." "Should be heard in regard to such questions." "Should be subject to the head of department." "In ——— department, have a voice determining departmental policy." "Too many professors think they should have sole control. 'Their policies might be disrupted.'"

14. "In the large departments his influence is small in determining [these matters]; in small departments he very often takes the place of the professor or head of the department in this line of work. In many cases has entire charge of department and is assistant professor in name only." "I have independent charge of [my field]." "In our department we have voice in the determination of the nature of the work." "The professor of ——— here decides all matters of departmental policy, curriculum and assignment of courses."

15. "In my department the head makes his own policies and assigns courses, but in some departments the assistant professors are consulted." "Suggestive share." "Should be consulted and allowed to help in this part of work."

16. "Should be consulted in the same way as any full professor not head of the department, and should have a vote in all matters submitted to vote of members of department." (Less than three replies.)

17. "No difference here in these matters between assistant and full professors."

18. "They have a great deal of influence here." "Am running the department pending a future policy to be settled in which I have some voice. In other departments assistant professors have advisory functions and are given considerable freedom on the average." "We have some voice—yet the dean has things about his own way." "Share equally with full professors." "Perfectly satisfactory."

19. "Depends largely upon the department head. In my own department the assistant professor is treated on his merits as a man and has as much influence as he deserves. This is not true in many other departments." "Seldom consulted." "Has a full share in departmental matters." "Made to feel that he has a voice in the government of the university and much at stake in his own department." "In general the assistant professor's position in these matters is entirely satisfactory."

20. "In general, little or none." "Much influence in departmental policy."

On the whole, these results, while showing more free participation in departmental than in general university matters, still disclose a state of affairs far from generally democratic.

The next query (18*c*) was in regard to the freedom enjoyed by the assistant professor in the conduct of individual classes. Here the replies are much more uniform, disclosing, in general, a gratifying condition of entire freedom, within the limita-

tions necessarily imposed by correlation of departmental work. There is, however, a plentiful sprinkling of "Should have control," which sounds as if the wish rather than the possession were father of the thought; and also others, of which the following are selected as typical: "None." "Given, usually, freedom in conduct of my classes." "A marked tendency on part of head to urge his own methods." "The professor of ——— decides the texts to be used and the amount of work to be covered." "The presence of his superior in the room (as is the case in some departments) overseeing his work is, to express it mildly, damnable." "In general, not enough freedom is allowed in those courses which require several sections taught by several men." By way of variety, one reply suggests: "Possibly less freedom and more supervision in some cases might be better."

The aim of query 19 was to disclose the conditions of nature and amount of work required, and whether these reasonably favor carrying on advanced work and intellectual growth. Eleven blank or noncommittal replies were received. Exactly 50 reported conditions from "reasonably" to "extremely" satisfactory. Fifty-one reported conditions as unsatisfactory for one or more of the following reasons: Excess of elementary work; correcting exercises; preparation of laboratory material; committee work; inadequate equipment or library; heavy schedule of instructional work; lack of presence and inspiration of advanced students, and pressing need to spend all available time in supplementing salary.

The actual amount of scheduled work seldom ranged below 10 hours, while as high as 18 appears to be the rule at some of the institutions; as high as 20 is reported and 15 is not uncommon. Here are a few typical, significant replies: "Have ideal research position." "So many do not take advantage of the existing opportunities that I should suppose a reduction of routine duties would not be of advantage to the university." "Conditions not favorable to research beyond that necessary to do teaching well." "Have had almost no time for past five years for research or investigation." "Nights, holidays and vacations must be used for advanced work instead of recreation." "An excess of work is not forced upon us, but it is at hand, and the conscientious man does it to the detriment of his own studies." "It is only by working to the limit that I am able to carry on any research work." "The nature and amount of work demanded of me have made me deem it necessary to aim at good teaching. This has been favorable to intellectual growth but not to research." "The heaviest part of the burden of routine teaching work is borne by those below the rank of professor. There is, however, good opportunity for research and advanced work, if one could be relieved of the awful feeling of lack of material provision for the future, and of family responsibilities not adequately met in the present."

The twentieth question was: What are the conditions governing tenure of the assistant professorship, and are they the best for reasonable independence of thought and action? Typical replies are here grouped, not according to individual institutions, but according to the seven prevailing systems of tenure. In the outset it should be stated that, judging by the entire lack of mention of such in the replies, influences upon tenure from outside the university are gratifyingly non-existent.

1. No fixed policy.

"We have no fixed policy. Would be more

satisfactory to plan for the future with more certainty."

2. Indeterminate. Continued from year to year.

"A man's tenure depends upon his worth." "Assistant professors are not supposed to have independence of thought and action. They are treated as mere assistants just out of college." "Wholly dominated by head of department." "I believe in some cases the institution might be better served if there were not so much independence of thought and action indulged in."

3. Annual appointment.

"The tenure of office depends, if I mistake not, on the wishes (1) of the head of the department and (2) of the president. The actual appointment is for the year only. The condition is unfortunate. It can not tend to independence of thought and action, but only the reverse. It cultivates subservience, toadyism. Its ill effect is intensified by the fact that the assistant professor has no open market in which he may offer his wares; an 'agreement in restraint of trade' virtually exists among leading universities." [?] "The under men are at the mercy of the head of the department, and must submit to any treatment if that head is autocratic or overbearing. Some heads keep their men reminded that they may lose their positions." "Until . . . I cringed and trimmed and was not half a man in my own esteem. I know dozens who are fawning because they feel it necessary." "One can not know whether he is to be dropped out at the end of the year or not. To establish anything like a permanent home seems out of the question." "I think that a three- or five-year term would be preferable, but, if the president is a competent person, I do not regard the matter of great importance." "Continuance in position and promotion are automatic, provided incumbent's efficiency is reasonably maintained." "All that should be asked for."

4. Three years.

"Reasonable for a first term." "Just a little better than one-year tenure." "This seems to me reasonable and fair and theoretically most stimulating for good work." "I am inclined to think that, for one thing, under the three-year tenure worry over future possibilities more than offsets any advantage of stimulus to do good work as means of retaining position." "Conditions by no means best. When I lost out at ——— I had a contract with the president and regents for three years, and two of these years were yet before me. It was deliberate breach of contract. . . . I was never allowed to face my accusers, nor do I know who they were. When I expostulated with the dean, he bullied me. I am not a fighter and could not stand up for myself. He literally bullied me out of the university. . . . The moral shock of this experience I never shall recover from." "I know of no restrictions on thought and action except in a few departments, the heads of which are inclined to be domineering." "In my institution the assistant professor is theoretically independent, having (after three years) an equal voice in the council and the department. Practically, however, he is dependent on the good-will of the head of the department. In the two vital matters of salary and promotion he has no personal access to the president, with whom the formal initiative rests, but is obliged to depend upon whatever representations the head of the department may choose to make. The latter's written recommendation is necessary to promotion, and his report is indeed the basis of all action taken by the president in reference to an assistant professor." "It would seem that the work of the assistant professor should be estimated by more than one person (usually the head of the department) and that some systematic method should obtain by which the appointing and promoting powers should be made acquainted with this work from more than one point of view." "I should say they are here what they are everywhere else: making oneself generally agreeable and setting up no opposition to superiors. Thus are fostered obedience, patience, self-control, submergence of self—all cardinal virtues. Independence of action is not for the assistant professor—his thoughts are his own." "In my experience the conditions are not the best for independence."

5. Four years.

"It is a temporary appointment for four years, and hence in a few cases operates to suppress independence of action and thought, though in most cases I see no such difficulty. Tenure usually depends on good work and usual standards of conduct."

6. Five years.

"Appointments for term of five years each; ordinarily leading to a professorship at the end of the second. There is entire independence." "Tenure dependent upon 'making good.'" "Have had no anxiety about reappointment." "Fact of reappointment being uncertain even though probable, militates against absolute independence of thought and action."

7. Permanent (sometimes after probationary term).

"Utmost freedom." "Removal for cause only." "If I understand the conditions, they are: Good behavior, efficient teaching and reasonable intellectual growth. If this is correct, I think they are the best possible."

No comment is necessary, beyond calling attention to the fact that undue subordination is destructive of character of both subordinate and superior; and conditions which tend to foster it should be tolerated no longer than it will take to get rid of them.

So much for the existing conditions as viewed by the assistant professors. We may compare our impressions from their conclusions with this by President Eliot:[7]

The young American who chooses a university career must then abandon all expectation of riches, and of the sort of luxuries which only wealth can procure. What he may reasonably expect is a secure income, a life-tenure, long vacations, the gratification of his intellectual tastes, good fellowship in study, teaching and research, plenty of books and a dignified though simple mode of life.

We now turn to their suggestions concerning the problem of the assistant professorship, looking toward higher individual or institutional efficiency. These have been grouped as well as may be under separate headings and the most revolutionary one is here given the place of honor:

1. Abolish the assistant professorship.

"Let the instructor be a temporary appointee. After he has clearly proven his ability let him be appointed to a professorship. The instructor should have little or no voice [in administrative matters or those of educational policy] while all the professors should be on an equality."

2. Appointment.

It is urged that the dignity of the position could be increased by the exercise of greater care in appointment, that the aim should be to get good men and then to give them plenty of opportunity for development, holding them responsible for results; and not to be overparticular about degrees and publications. There is nothing very radical here.

3. Clear understanding of status.

[7] "University Administration," pp. 98–99.

Policies should be well-known, clear-cut and loyalty insisted upon; these men wish to cooperate and to that end desire that they be given the confidence of their seniors, and not to be kept intentionally in the dark as to the possibilities of their position or the scope of their work. "Each man (president, professors, instructors, etc.) should have a better understanding with all his associates as to what specific purpose in the world he is trying to accomplish, and in what details he is responsible and in what details only an agent. The whole to be open and aboveboard."

4. Facilities.

In addition to such criticism of limitations of library or lack of equipment from which all members of the staff suffer alike, the assistant professor feels that his needs of office and research room and occasional clerical or stenographic service are overlooked.

More serious than this is the complaint that he has no voice in making up the department budget and that, as a consequence, serious injustice is sometimes done his classes and himself by an indifferent or unfriendly head of department. In the following quotation I change the actual figures —to prevent identification—but retain their essential ratio:

"Our department has $5,000 this year for current expenses. Although second in rank in a department of five men, my grant was only $85. This sum was soon exhausted, and from ——— until next July my laboratories must get along as best they can without funds. In this matter the head of the department has absolute power, from which there is no appeal."

The failure to include in book-lists those which the assistant professor requires for his advanced work and growth is also not unknown.

Facilities for the publication of longer, more ambitious work, rather than short papers, are inadequate. There are occasional instances where he has been urged by the superior, upon whose good-will the permanence of his position and advancement depend, to undertake such a task and upon its completion face the necessity of paying a large sum toward its cost of publication out of his scanty resources.

5. Schedule and curriculum.

The burden of instructional work is too heavy to encourage or even, in many cases, to permit research work. The suggestion is made that there is too great a variety of undergraduate courses offered.

The men should have some share in the advanced

courses and must be given entire control of the conduct of their own classes except for the natural limitations imposed by the need of correlation of courses. They should be free as to methods, but held strictly accountable to the university for results.

6. Tenure.

The comments on tenure leave no doubt that a short term—like annual appointments—dominated by the head of the department is not wholesome and should not be tolerated. Probationary service, either in rank of instructor, or one term as assistant professor, is recognized as necessary and desirable; but a continued state of uncertainty is demoralizing. No institution—even for the gain of apparently frictionless administration—can afford to pay the price in injury to dignity and character disclosed by some of these letters.

7. Promotion.

The standards for promotion should be formulated, openly stated, and adhered to. It is urged that recognition be given to teaching ability and that promotion depend not solely on research work when the burden of teaching makes this so generally impossible. "Promotion should not depend upon aggressiveness in cultivating friendships of those in authority, popularity with students or alumni, capacity for routine administrative work, or the personal favor and persistence of the head of the department." Character, personality, ability and reputation in the world of scholars should be the determining factors. Uniformity of standards in the different departments is highly desirable—the prevailing systems of indefinite tenure and recommendation by department heads tend to make as many different standards within a single university as there are heads. Each man's case should automatically come up for consideration at fixed intervals and at these times he should be given an opportunity to present such evidence of fitness for promotion as he may feel he has to offer. The conclusions as to his position should then be clearly stated to him.

8. General faculty status.

The faculty should be the supreme academic body. There should be more team-work and cooperation throughout. These men should have a voice and vote in determining the general educational policies. Fear need not be entertained that they will be too zealous or aggressive in the presence of older men whose judgments they have learned to respect. They wish to feel themselves a vital part of the institution and not mere employees. They wish to learn about these matters so that they too can give them intelligent consideration, get a view of their work in its broader aspects and relations, and receive some systematic training for the duties and responsibilities of higher positions. They have no desire to displace the older men—nor even to intimate that younger men have a great many new and invaluable ideas—but they do feel that a gain may come to an institution in preventing an attitude of settled convictions and consequent lack of further interest in its problems, by injecting a constant stream of fresh blood. To counterbalance their lack of academic experience (after seventeen years as students and teachers) they offer an "idealism which has not been too rudely shaken."

9. Department status.

One of the tragedies of life is the way we are continually closing the doors behind us and forgetting the lessons which our experiences should have taught us. Nowhere, in this study, has this fact appeared more clearly than in the delicate matter of department organization. It is well, therefore, to listen to the voice of our composite assistant professor on this subject: "The assistant professor should have a voice and vote in all departmental matters as a matter of right and not merely as a concession of the head of the department." "I regard a democratic organization of the departments, with full discussion of concrete problems of instruction, as of the highest importance. Without it proper cooperation of different instructors can not be obtained. It indirectly contributes to an intelligent discussion of general educational problems in faculty meetings." "The president to be the head of each department and to see that the men in all departments have uniform treatment." "The organization at ———, of departments with heads having large powers, is prejudicial to professors and assistant professors who are not department heads. A democratic organization of departments would be much more healthy—less immediately efficient but sounder in the long run."

In a democratic society the presence of a privileged class, or of one a considerable portion of which feels itself deprived of natural participation in affairs with which it is vitally concerned, is not wholesome. The solution of this vexed problem, already reached and long in satisfactory operation, at one of our leading institutions, seems to be a democratic departmental organization, having a

chairman, of strictly limited powers, on temporary appointment to the post.

10. Salary.

A general increase of salary in this rank is an imperative necessity; sufficient evidence of this has been presented. The cost of living has increased 50 per cent. in the period of teaching service of these men,[8] the requirements for promotion to the rank are much higher than they were twenty years ago, but there has been little change, on the whole, in the average rate of compensation. The gap between the salary of the assistant professor and that of full professor has, furthermore, greatly increased, thus adding to the difficulties of the former; for the compactness of the university community is well known. By taste, training, ability, aims and aspirations, all belong to one social class, with practically similar demands and obligations.

The institution, as well as the men, is loser by the present low standard, as a low mental tone is induced by worry; there is much loss of time in earning the necessary supplemental income, not to speak of the unfortunate dissipation of interest and energy; there is prevention of growth and development; save for single men the salaries are inadequate to provide books, necessary equipment, travel, attendance at meetings of learned societies and associations, or to permit the taking of a sabbatical year. In this latter regard, a sabbatical half-year on full pay is urged. The inadequacy of the salaries is driving many good men from the profession. "So much is this true that I am now seriously debating whether to resign now, and practise my profession, or to wait another year for a possible call to some other place." Or this, from a letter of one who had already resigned before the questionaire reached him: "While I would rather teach than do anything else, and expect to continue in that work, it must be along clinical lines, and my living must come from my practise. In other words, teaching *per se*, particularly in the fundamental sciences, is a very much underpaid profession—certainly not sufficient for the support of two persons with the possibility of additions."

A definite and adequate salary scale is a bitter necessity. Parenthetically it may be stated that an average readjustment of 3 per cent. of the total annual budget would probably suffice to relieve the situation in this rank.

[8] See "Bradstreet's," December 9, 1899, and November 13, 1909.

In summing up the aspirations of these men, I can do no better than to quote the words of the late President Canfield:

The three controlling desires of every normal man seem to be:

First, to live. Not merely to exist. Almost any one can exist in these days and especially in this country of ours. Mere existence is so easy and so common that a failure to secure this becomes noteworthy: the starvation of a single person in a population of nearly eighty millions becomes at once such an item of news that it is wired from one end of the country to the other and is commented upon by the daily press under special headlines. But the normal man desires something more than existence. He desires to live, in the sense that he wishes his fair share of those things which give color and meaning to his century. His home must be more than a mere shelter; it must be convenient and attractive and satisfying. His clothing must be such as to spare him the unfavorable comment of his fellows. Steam and electricity must minister to him, directly or indirectly. The current press must be at his reasonable command. Of libraries and art galleries and museums he must have the privilege of use, and his necessary labor must not deprive him of the opportunity of enjoying that privilege. He must be able to make his house a home by adding a hearth—and there is no hearth for a man but the heart of a woman. In a word, he must be able to live as a breadwinner and husband and father and good citizen ought to live. This is not only his own right, but the rightful demand of the welfare of the entire community.

Second, to be a man among men. He is not to be content while he remains unrecognized and unknown. He is not simply a unit to be counted, but a man to be weighed and reckoned with. He wishes to stand shoulder to shoulder with his fellows, to look level in the eyes of other men with a sense of equality and power, to feel that his experience and his observation and his resulting opinions are of value to the world and the value is recognized, that men hesitate as to certain undertakings until they know where he stands. He will not admit that he is only a fraction of a man, but insists that he is at least one of the full integers which make up the sum of life. He is not to be a flint that never strikes fire. His nature desires and demands the esteem and the regard and even the affection of his fellows.

Third, to do that which will endure. He will have no part in oblivion, he is unwilling to be forgotten, he can not abide the thought that his work is to perish, that all that to which he has given his time and strength and thought and power comes to an end simply because his body dies. He wishes to project his temper and his purpose and his plans into the future, to find in this way and even here the beginnings of immortality, so to labor that at least a part of his finite product may be worthy to be woven in and in with the divine plan and thus become lasting and infinite.

GUIDO H. MARX

STANFORD UNIVERSITY

(To be continued)

THE ELEVENTH INTERNATIONAL CONGRESS OF GEOLOGISTS, STOCKHOLM, 1910

RESPECTING the progress of the arrangements for this congress, which is to be held in Stockholm, August 18–25, the secretary-general of the congress has given the following information (February, 1910):

The deliberations of the congress will principally concern the discussion of the following questions:

1. *The Geology of the Precambrian Systems.*—The discussion is divided into the debate of the following special questions: (*a*) To what extent can it be proved that the characters of Archean rocks are due to a deep-seated metamorphosis? and (*b*) The principles of a classification of the Precambrian formations, especially as to what extent a classification after age, of local or universal importance, can be carried out. The following gentlemen have hitherto held out short introductory lectures for this discussion: F. D. Adams, Ch. Barrois, F. Becke, U. Grubenmann, J. F. Kemp, A. C. Lane, J. J. Sederholm and P. Termier.

2. *The Abrupt Appearance of the Cambrian Fauna.*—Messrs. Ch. Lapworth, G. F. Matthew, A. Rothpletz, C. D. Walcott and J. Walther have promised contributions on this subject.

3. *The Changes of the Climate Since the Maximum of the Last Glaciation.*—As an introduction to this discussion three Swedish scientists (G. Andersson, G. De Geer and R. Sernander) published last spring comprehensive descriptions of matters of fact observed in Sweden, which are conclusive for the explanation of the postglacial climatic deviations in that country. These three essays were sent to a considerable number of foreign scientific men that have occupied themselves with the question of postglacial climate, and these gentlemen were at the same time requested to cooperate in an international discussion of this problem. The Swedish Committee desires the cooperation in this international debate in such a manner that from each country but one report on the postglacial climatic deviations observed there should be sent in. In consequence of this invitation already several treatises on the said subject have been sent in and scientists from the following countries have hitherto promised their cooperation: Austria, Belgium, Canada, the Cape Colony, Denmark, Egypt, England, Finland, France, Germany, Hungary, India, Italy, Norway, Russia, Sweden, Switzerland. Reports on the arctic and antarctic regions have also been received.

All the treatises, sent in from the different countries, will be collected in an autonomous work: *The changes of climate since the maximum of the last glaciation.* This publication, which will probably be ready in the course of the month of April, will form the basis of the coming discussion. This work will be sent free of cost to the contributors. Besides, it will also be procurable, at a price not yet fixed, from the publisher, "Generalstabens Litografiska Anstalt," Stockholm 3.

4. *The Iron Ore Resources of the World.*—In the beginning of 1908 the committee of the congress sent to the national geological institutions and to the mining geologists in the different states invitations to take part in an exhaustive investigation of the above question. This request has everywhere met with so much attention that, at present, reports from nearly all the iron-ore producing countries of the world have been received which will be collected in one work: "The Iron-ore Resources of the World." This publication, consisting of

about 900 pages in quarto with numerous plates and illustrations in the text and accompanied by an atlas of 40 map-sheets, will shortly be ready. It will be sent free of cost to the governments of the cooperating states and to the collaborators, and it will also be procurable from the above-mentioned publisher at a price of £3. This work will form the basis for the discussion at the congress of the possibilities of the future iron and steel industry to procure the raw material.

5. *The Geology of the Polar Regions.*—This subject will be treated in a series of special lectures, of which the following have hitherto been advised:

H. Jarner: "The Geological Results of the *Danmark* Expedition to Northeastern Greenland."

A. G. Nathorst: "The Climatic Testimony of the Fossil Floras in the Polar Regions."

J. F. Pompeckj: "The Jurassic Deposits of the Arctic Region."

N. V. Ussing: "The Eruptive Area of Tlimausak—Western Greenland."

Besides, one of the geologists of the last British Antarctic Expedition will give a report on the geological results of this expedition.

In connection with the discussion of polar geology there will be an exhibition arranged of the geological collections brought home by Swedish expeditions from the arctic and antarctic regions.

The debates of the congress will principally relate to the discussion of the above questions. Isolated lectures, of which the committee has been informed, will be placed in one of the following sections:

1. General and regional geology. Tectonic matters.
2. Petrography and mineralogy.
3. Stratigraphy and paleontology.
4. Quaternary formations. Recent glaciers.
5. Applied geology.

In connection with the congress the following excursions will be arranged:

A. Excursions before the Congress.

1. Spitzbergen, July 25 to August 17. Leader: G. De Geer.
2. Norrland (over-thrusts, eruptives, iron ore fields), July 27 to August 17. Leaders: A. G. Högbom, Hj. Lundbohm and P. J. Holmquist.
3. Iron-ore fields of Gellivare and Kirunavaara, August 6–17. Leader: Hj. Lundbohm.
4. Quaternary geology of the Torneträsk, August 6–17. Leader: O. Sjögren.
5. The Alps of Sarek, July 27 to August 17. Leader: A. Hamberg.
6. Quaternary geology of Angermanland and Jämtland, August 9–17. Leader: A. G. Högbom.
7. Peat-moors of Närke, August 10–16. Leader: L. v. Post.

B. Excursions during the Congress.

Several excursions of one day, principally in the environs of Stockholm.

C. Excursions immediately after the Congress.

1. The Archean rocks of middle Sweden, August 26 to September 4. Leaders: A. G. Högbom, P. J. Holmquist, A. Gavelin and H. Hedström.
2. Silurian deposits of Gotland, Dalarne and Västergötland, August 25 to September 6. Leaders: H. Munthe, H. Hedström, C. Wiman and E. Warburg.
3. Quaternary geology of southern Sweden, August 26 to September 8. Leaders: G. De Geer, H. Munthe and A. G. Nathorst.
4. Ore fields of middle Sweden, August 26 to September 6. Leaders: Hj. Sjögren, W. Petersson and H. Johansson.
5. Morphology of middle Sweden, August 26 to September 4. Leaders: O. Nordenskjöld and S. De Geer.
6. Plant-containing mesozoic deposits in Skåne, August 26–29. Leader: A. G. Nathorst.
7. Cretaceous system in Skåne, August 25–29. Leader: A. Hennig.

D. Excursion in Skåne after the conclusion of group C.

Silurian deposits, September 7–13. Leader: J. C. Moberg.

In the beginning of March the second circular of the congress will be sent out, containing full particulars about the excursions and a statement of costs, etc.

All correspondence relating to the congress to be addressed to the secretary-general, Professor J. G. Anderson, Stockholm 3.

Synchronous with the Congress of Geologists and in intimate connection with it "The Second International Agrogeological Conference" will be held in Stockholm. The secre-

tary of the same is Dr. H. Hesselman, Valhallavägen 25, Stockholm.

THE BROOKLYN BOTANIC GARDEN

A Brooklyn Botanic Garden is now being established by the City of Greater New York in cooperation with the Brooklyn Institute of Arts and Sciences. Between twenty-five and thirty acres of land, south of the museum building of the institute in Brooklyn, and separated from Prospect Park by Flatbush Avenue, have been set apart for the purposes of the garden, and are now being surveyed and graded. A laboratory building for purposes of investigation and instruction, together with a range of experimental and public greenhouses, will be constructed during the coming summer and autumn. For this purpose the City of New York has appropriated $100,000. In addition to this, friends of the garden in Brooklyn have subscribed $50,000 as an endowment, the income of which is to be used for the purchase of equipment. It is intended to make the new garden not only a center of research, but also to give instruction to both elementary and advanced classes in botany, and cooperate in every feasible manner with the botanical work of the public and private schools of the Borough of Brooklyn. Dr. C. Stuart Gager, professor of botany in the University of Missouri, has been appointed director of the garden and will enter on his duties the first part of July. A scientific staff will be gradually assembled as soon as the buildings are ready for occupancy.

SCIENTIFIC NOTES AND NEWS

Dr. George W. Hill, of Nyack, N. Y. and Professor E. B. Wilson, of Columbia University, have been elected foreign members of the Brussels Academy of Sciences.

The Rumford Committee of the American Academy has recently made the following grants in aid of research: To Professor Joel Stebbins, $350, in aid of his research with the selenium photometer. To Professor W. W. Campbell, $125, in furtherance of the research on the polariscopic study of the solar corona by means of a Hartmann photometer. To Mr. Frank W. Very, $50, for the purchase of photographic glass plates of the spectrum by Higgs. To Professors C. E. Mendenhall and Augustus Trowbridge, $250, in aid of their research on the effect of ether drift on the intensity of radiation. To Professor C. E. Mendenhall, $250, in furtherance of a research on the free expansion of gases. The committee has also made a grant of $250 to Professor Gilbert N. Lewis in aid of preparation of abstracts for publication in light and heat for the forthcoming International Physico-chemical tables.

Professor E. G. Conklin, of Princeton University, has been appointed to represent the National Academy of Sciences at the Zoological Congress at Gratz, Austria, and at the meeting of the International Association of Academies at Rome, Italy.

The American Philosophical Society has appointed Professor E. G. Conklin, of Princeton University, a delegate to the eighth International Zoological Congress at Gratz, Austria, August, 1910; Professor George L. Goodale, of Harvard University, a delegate to the International Congress of Botanists at Brussels, May, 1910, and Professor Frederick W. Putnam, of Harvard University, a delegate to the Congress of Americanists in the City of Mexico in September, 1910.

Professor Sir J. J. Thomson has been nominated to represent Cambridge University at the celebration in October, 1910, of the centenary of the University of Berlin.

The Biological Society of the Massachusetts Institute of Technology gave a dinner in honor of Professor Wm. T. Sedgwick, on March 17, prior to his departure for Europe. Speeches were made by President Maclaurin, Professor Talbot and Professor Porter, and Professor Sedgwick replied.

Dr. Henry Fairfield Osborn, president of the American Museum of Natural History, and Dr. Charles W. Dabney, of the University of Cincinnati, are among those who have been chosen as electors for the Hall of Fame of New York University.

PROFESSOR BASHFORD DEAN, Columbia University, has recently been decorated by the French government chevalier de la légion d'honneur in recognition of his services to zoology in France.

DR. H. A. MIERS, F.R.S., principal of the University of London, has been elected a member of the Athenæum Club for "eminence in science."

DR. C. LLOYD MORGAN, F.R.S., for upwards of twenty years principal of University College, Bristol, first vice-chancellor of the university and now professor of psychology and ethics, has received a presentation from the staff and students of University College and friends. The gifts consisted of several substantial pieces of plate and £200 worth of books.

THE Marquis Cappelli has been appointed president of the International Institute of Agriculture at Rome, to succeed Count Faina, who has resigned owing to diplomatic troubles about minor appointments under the institute.

THE following officers of the Pellagra Investigation Committee have been selected: *Chairman,* Sir T. Lauder Brunton; *vice-chairman,* Dr. F. M. Sandwith; *honorary secretary and treasurer,* Mr. J. Cantlie; *advisory subcommittee,* Mr. E. E. Austen, Professor E. C. Bayly, Sir William Leishman, Dr. J. M. H. MacLeod, Sir Patrick Manson, Sir John McFadyean, Dr. F. W. Mott and Professor Ronald Ross. The *field-workers* will be Dr. Louis W. Sambon, of the London School of Tropical Medicine, and Captain J. E. Siler, with Mr. Arthur Dawson-Amoruso and Mr. G. C. C. Baldini as assistants.

DR. H. H. BUNZEL, assistant in physiological chemistry at the University of Chicago, has been appointed biochemical expert of the Bureau of Plant Industry in the U. S. Department of Agriculture.

DR. J. H. CREIGHTON, professor of philosophy at Cornell University, will have leave of absence next year. His course will be taken by Dr. G. H. Sabine, of Stanford University.

PAST ASSISTANT SURGEON C. H. LAVINDER, of the Public Health and Marine Hospital Service has been sent to Milan and other places in Italy for the purpose of making an investigation into the origin and prevalence of pellagra and into the measures being taken to combat the disease.

MR. W. G. BATEMAN, lately instructor in chemistry in Stanford University, has sailed for China to take up his work as professor of chemistry in the University of Tiensin.

DR. V. FRANZ, assistant in the biological station in Heligo Land, has been appointed head of the department in the Frankfort Neurological Institute.

PROFESSOR W. M. FLINDERS PETRIE has accepted the presidency of the Hampstead Scientific Society, in succession to Sir Samuel Wilks, F.R.S., who has resigned.

DR. JOHN M. COULTER, head of the department of botany, was the orator at the seventy-fourth convocation of the University of Chicago, on March 15. The subject of his address was "Practical Science."

DEAN F. E. TURNEAURE, of the College of Engineering of the University of Wisconsin, reported at the eleventh annual meeting of the American Railway Engineering and Maintenance of Way Association at Chicago last week on the work of the special committee on the effect of high speed and weight of trains on steel and iron bridges, of which he is chairman.

DR. ELLSWORTH HUNTINGTON, of Yale University, on February 26, lectured before the students of Denison University on "The Untamed Inner Border of Palestine."

THE Bakerian lecture of the Royal Society was delivered on March 17 by Professor J. H. Poynting, F.R.S., and Dr. Guy Barlow, on "The Pressure of Light."

AMONG the lectures to be given at the Royal Institution, London, after Easter, is a course of three on the mechanism of the human voice, by Dr. F. W. Mott, F.R.S., Fullerian professor of physiology; Professor C. J. Holmes will give two lectures on heredity in Tudor and Stuart portraits; and Major Ronald Ross, F.R.S., two lectures on malaria. The Tyndall

lectures on electric heating and pyrometry will be given by Professor J. A. Fleming.

Dr. Alfred Tuckerman, historian for the American Association for the Advancement of Science, requests us to state that if members of the American Chemical Society who have had correspondence with the late Dr. Charles B. Dudley will send it to him at the Smithsonian Institution, Washington, D. C., it will be safely preserved and will be accessible to those interested.

The Rev. Carr Waller Pritchett, formerly director of the Morrison Astronomical Observatory and president of Central College and Pritchett College, Missouri, died on March 18, at the age of eighty-seven years.

Professor Edward A. Bowser, for thirty-three years professor of mathematics and engineering at Rutgers College, died at Honolulu, at the age of sixty-five years.

George Willis Kirkaldy, an entomologist, known for his work in hemipterology, died at San Francisco, on February 2, in his thirty-sixth year.

Dr. E. P. Wright, for many years professor of botany in Dublin University, has died at the age of seventy-six years.

At the general meeting of the American Philosophical Society in April, 1909, a committee on South Polar exploration was authorized. The resolutions in reference to the matter were sent to all the scientific bodies naturally interested in such exploration, and were supported very widely by them. Later the following were appointed members of this committee: Edwin S. Balch, Henry G. Bryant, Hermon C. Bumpus, Wm. Morris Davis, George W. Melville, Henry F. Osborn and Charles D. Walcott. The committee has been actively at work to promote the exploration of the South Polar region by an American expedition under the auspices of the government. The Navy Department is actively interested in the matter, and it is hoped that the expedition will be definitely authorized before long.

Sixty committees on the prevention of tuberculosis in various parts of the state of New York met at Albany last week. At the session on March 18, the Hon. Joseph H. Choate presided and among those making addresses were Dr. Simon Flexner, director of the Rockefeller Institute of Medical Research, and Dr. E. L. Trudeau.

The summer meeting of the American Institute of Chemical Engineers will be held at Niagara Falls, N. Y., from June 22 to 24. A prominent feature of the meeting will be visits to the interesting chemical industries in this locality. An important program of papers is being arranged for by the committee on meetings.

A Physics Club at Philadelphia has been organized with Professor George A. Hoadley, of Swarthmore College, as president and Dr. Guy W. Chipman, of the Friends' Central School, as secretary and treasurer. There are at present forty-three members. At the fourth meeting held at the Central High School, on March 11, Dr. Paul R. Heyl, of the Central High School, presented a paper on the magnetic storm of September 25.

The eighth International Physiological Congress is to be held at the Physiological Institute of the University, Vienna, from September 27–30 next.

The British Medical Association will hold its seventy-eighth annual meeting in London, July 26 to July 29. The president's address will be delivered on July 26 and the sections will meet on the three following days. The president of the association is Sir William Whitla and the president-elect Mr. H. T. Butlin.

The *Medical Record* states that the Forsyth Dental Infirmary is soon to be incorporated in Boston as a result of a donation of $2,000,000 made by Mr. Thomas A. Forsyth, of that city. The infirmary is to be located in Hemenway Street in the Back Bay, is to be thoroughly equipped and manned for modern dental surgery, and is to be free to any child under sixteen years of age. The purpose of the clinic is to give free care of the teeth to every child in Boston.

AMONG the recent gifts to the U. S. National Museum are a series of minerals from Cobalt, Ontario. These include a specimen of niccolite which is an arsenide of nickel and shows the rich metallic luster so characteristic of all nickel ores. Another is a fine specimen of breithauptite, which is a combination of nickel and antimony, with strings of native silver in a matrix of calcite. The slender veins of these two metallic ores wandering irregularly through the white limestone are most attractive. With these there is also from the same locality a specimen of the mineral, known as smaltite which in composition is a combination of cobalt and arsenic. It has a white silvery appearance and is a good cabinet specimen.

THE twenty-first session of the Biological Laboratory of the Brooklyn Institute of Arts and Sciences located at Cold Spring Harbor, Long Island, will be held for six weeks beginning Wednesday, July 6. The courses offered comprise field zoology by Drs. H. E. Walter and C. B. Davenport; bird study by Mrs. H. E. Walter; comparative anatomy by Drs. H. S. Pratt and A. A. Schaeffer; general embryological and microscopical technique by Miss Mabel Bishop, of Goucher College; cryptogamic botany by Dr. D. S. Johnson, of Johns Hopkins University, and Mr. H. H. York; ecology by Dr. H. S. Conrad, of Grinnell College. For the first time a course for teachers on the principles of agriculture is offered under the direction of Professor H. H. Laughlin, of Missouri State Normal School, at Kirksville. The usual facilities for beginning investigation under the direction of the instructors are offered and a limited number of tables and private rooms are available for investigators. Those who desire to make use of the facilities of the laboratory for investigation may address the director, C. B. Davenport, Cold Spring Harbor, N. Y., from whom announcements may be obtained.

THE *Geographical Journal* is informed that a scientific expedition to Colombia is being organized at Neuchâtel, under the auspices of the Société Helvétique des Sciences Naturelles, the leader being Dr. O. Fuhrman, professor of zoology at Neuchâtel University. It is hoped that a start will be made in July next, and the main objects kept in view will be the study of the fauna of the lakes and rivers of central Colombia, as well as the parasitic flora, but geological and geographical observations are also contemplated. Dr. Fuhrmann will be accompanied, as botanist, by Dr. Mayor, of Neuchâtel. The Magdalena will be ascended from Baranquilla to Puerto Berrio, whence the party will proceed to Medellin. From this and other centers excursions will be made to various parts of the central Cordillera and the region of the Cauca, the travelers afterwards turning their attention to the Paramos of the eastern Cordillera, and making excursions in various directions from Bogotá. Halts will also be made later at Honda and Puerto Berrio, during the return journey to the coast.

UNIVERSITY AND EDUCATIONAL NEWS

MRS. HELEN HARTLEY JENKINS has given the University and Bellevue Hospital Medical College $100,000 to endow the Marcellus Hartley professorship of medicine.

MR. CHESTER W. LYMAN, of New York, has given $5,000 to the Sheffield Scientific School of Yale University for a lectureship on the subject of water-storage conservation to be known as the Chester W. Lyman lectureship in memory of the donor's father, who was for many years professor of physics and astronomy in the Sheffield Scientific School.

A FRIEND of the Allegheny Observatory has endowed a fellowship in astronomy at that institution. The fellow is to receive $500.

IT is reported in the daily papers that Mr. John D. Rockefeller has given $150,000 to erect buildings for the American College for Girls at Constantinople.

MR. W. H. LEVER has offered to give to the University of Liverpool, property of the value of £84,000, which appears to have been the receipts resulting from a libel suit instituted against the London *Daily Mail* by Messrs. Lever Brothers.

The Duke of Portland has promised £2,000 towards establishing a chair of mining at Nottingham University College.

The trustees of Cornell University have decided to limit the work in the medical department at Ithaca to one year in the future instead of two, as has been the custom since the school was founded.

Of thirty-one elections to the Phi Beta Kappa honorary fraternity at Cornell University, nineteen are women, and of twenty-seven elections at the University of Illinois twenty are women.

Closer relations are being established between the College of Physicians and Surgeons, Columbia University, and the Mt. Sinai and German Hospitals in New York. The following members of the staffs of the hospitals have received appointments in Columbia University. From Mt. Sinai Hospital Drs. Brill, Libman, Gerster and Berg, and from the German Hospital, Drs. Kammerer, Stadtmüller and Hensel.

Dr. George P. Burns, of the University of Michigan, has been called to the chair of botany at the University of Vermont.

Mr. Leonard Doncaster, lecturer in the University of Birmingham, known for his work in zoology and especially in heredity, has been elected a fellow of King's College, Cambridge.

Mr. William Ray, Rhode scholar from Adelaide at Oxford, has been elected to the Philip Walker studentship at Oxford, for research in pathology. The fellowship is of the value of £200 a year for three years.

Dr. G. Haberlandt, of Graz, has been called to the chair of botany at the University of Berlin, vacant by the retirement of Professor Schwendener.

Dr. Karl Uhlig, of Berlin, has been called to the chair of geography at Tübingen, to succeed Professor K. Sapper.

Dr. Alfred Grund, of the University of Berlin, has been made professor of geography in the German University of Prague.

Dr. Ernst Meumann, of Halle, has been called to the chair of philosophy at Leipzig, vacant through the death of Professor Max Heinze.

DISCUSSION AND CORRESPONDENCE

THE DIRECTORY OF AMERICAN MUSEUMS

The Directory of American Museums of Art, History and Science, which is being prepared by the American Association of Museums, is nearly ready for the printers, and all museums which have not already returned information regarding their collections are urged to communicate at once with the undersigned.

The data desired include a list of the staff; an enumeration of the nature and extent of the collections, with comments on the more important material; a statement of the sources and amount of the financial support; particulars regarding the building, including the amount of floor space occupied; the scope and purposes of the museum; information concerning the museum library and publications, if any; and the times and conditions upon which the museum is open to the public, with statistics of attendance, if available.

The cooperation of the American museums is earnestly requested in order that the directory may be as complete as possible.

Paul M. Rea,
Secretary

The Charleston Museum,
Charleston, S. C.

A QUEER FISH

Some newspapers have connected me with the statement that a specimen said to be a fish with four legs was caught in Brazil. Permit me to say that the particular specimen has no legs and is not a fish.

C. H. Eigenmann

SCIENTIFIC BOOKS

*Lehrbuch der Protozoenkunde. **Eine Darstellung der Naturgeschichte der Protozoen mit besonderer Berücksichtigung der parasitischen und pathogenen Formen.*** Zweite Auflage der "Protozoen als Parasiten und Krankheitserreger." Von Dr. F. Doflein.

Pp. x + 914, mit 825 Abbildungen im Text. Jena, Gustav Fischer. 1909. M. 24, Geb. 26.50.

The rapid development in recent years of the science of protozoology to a position coordinate with bacteriology is reflected in the enormous increase in the literature dealing with the Protozoa. The *Archiv für Protistenkunde* founded by Schaudinn in 1902 is now in its eighteenth volume. For the year 1890 the *Zoological Record* lists 109 titles under protozoa, for 1900 there are 167, and 1905 no less than 522, the high-water mark to date.

This activity in research has not only brought to light countless details of structure, and increased many fold the categories of life-histories, but it has also complicated rather than simplified our general notions regarding the cytology of protists and the primitive processes of reproduction. The Protozoa are no longer to be regarded as simple organisms. It has likewise raised many hotly contested questions such as the life history and relationships of the trypanosomes, the relationships of the spirochætes and the occurrence and meaning of chromidia. It has brought to light not a few problematical protists, seen for example in those structures associated with such diseases as small-pox, measles, scarlet fever, epithelioma contagiosum and trachoma which Prowazek has grouped together as Chlamydozoa, as well as other less notorious organisms which are with difficulty allocated in existing categories, though beyond all question to be regarded as protozoa.

The stupendous task of assembling, coordinating and sifting this ever-increasing flood of protozoological literature into a "Lehrbuch" would be attempted only by a German, and even Dr. Doflein admits that he would not have undertaken the three years' "mühsamer Arbeit" had he clearly foreseen the magnitude of the task and the burden of reviewing the literature.

The author's treatment of this overwhelming mass of data has been facilitated by his own incursions into the different fields of research here represented. His treatment of contested points is wisely conservative and objective, though one is disappointed in not finding a full and critical discussion of the claims of the Chlamydozoa for admission to the category of protozoan organisms and regrets their summary dismissal.

The account of the sexual reproduction of *Trypanosoma lewisi* in the rat louse as described by Prowazek is regarded by Doflein as hypothetical throughout, resting upon too few observations, and these apparently upon abnormal stages. It remains to be seen if later work will not confirm the existence of a sexual cycle in an insect host. Schaudinn's account of the complicated life histories of the blood parasites of the owl is, perhaps more justly, dismissed as improbable in the light of the work of Novy and his collaborators.

The point of view from which the book is written is most commendable, to wit, to bring the results of investigations upon parasitic and pathogenic protozoa into correlation with our general knowledge of the natural history of the group. While the parasitic protozoa are given a large place in the systematic part of the text even to the exclusion of others equally interesting and important but non-pathogenic, the main outlines of the work and the general discussions are not thus limited but are conceived and elaborated along the broadest lines so that the work is of value to all who deal with protozoa or with the biological problems which they may elucidate.

The introductory treatment of the general morphology, physiology, reproduction and ecology of the groups forms the first third of the volume, while the remainder contains a systematic presentation of the phylum protozoa by orders and families carried to genera and species in many cases of important parasitic and pathogenic forms. Special chapters on the parasitism and pathological significance of the different groups are interspersed in this section.

The Flagellata are treated in 142 pages, the Rhizopoda in 132, the Sporozoa in 218 and the Ciliata in 47. With all due regard to the scientific, economic and social value of the pathogenic phase of protozoology, to the limitations of a single volume, to the relative de-

mand for and interest in the information regarding the different groups, and to their biological significance, many users of Dr. Doflein's book will doubtless agree with the reviewer that the non-pathogenic groups are all too inadequately represented. The Ciliata are especially unfortunate in coming up last for presentation in a volume rapidly approaching a thousand pages. One feels that the extensive and important recent work on the Radiolaria is very incompletely presented in the 18 pages mostly consisting of a perfunctory list of radiolarian families. In fact a new edition of Bütschli's Thierreich monograph is sorely needed to make possible a well-coordinated critical review of the whole group of Protozoa and this is a task which in the present state of the science can only be undertaken by a group of specialists. All protozoologists, biologists and pathologists will be profoundly grateful to the author for the book even with these minor limitations. It will also prove a stimulus to further research and greatly facilitate it. Problems requiring further elucidation are continually suggested in its pages.

The book is, beyond all question, the best illustrated work that has come from Fischer's famous press. This is due to the wise selection of figures, the inclusion of many original sketches made especially for the work, and to the uniformly careful preparation of the drawings, as well as to the high degree of technical skill in the reproduction. The only drawback is the reflection from the highly glazed paper which is very trying to the eyes.

An English translation of the work, revised to date, is in preparation by Col. Leslie in conjunction with Dr. Doflein. This will be especially welcome to English readers, since it makes the work available for instruction in academic and medical classes.

The book is fittingly dedicated to "meinem lieben Lehrer und Freund Richard Hertwig in Verehrung und Dankbarkeit," and comes logically from the laboratories at Munich, the foremost center in the world for protozoological research along comprehensive lines.

Charles A. Kofoid
University of California

Allen's Commercial Organic Analysis. Volume I. Introduction, Alcohols, Yeast, Malt Liquors and Malt, Wines and Spirits, Neutral Alcoholic Derivatives, Sugars, Starch and its Isomerides, Paper and Paper-making Materials, Vegetable Acids. By Henry Leffmann and W. A. Davis, editors, and E. F. Armstrong, J. L. Baker, G. C. Jones, E. Schlichting and R. W. Sindall, contributors. Fourth edition, entirely rewritten. Philadelphia, P. Blakiston's Son and Co. 1909. Pp. x + 576. Price $5.00.

It is eleven years since the last American edition of this well-known work was published. When we consider the very rapid advances which have been made in this field during recent years and also that the third edition was prepared so hastily as to prevent a thorough revision, the need of a thorough rewriting of the whole book is evident. The revision has been very thorough and a large amount of new material has been added.

No one individual can be thoroughly familiar by personal experience with the great variety of analytical methods presented in a book of this kind and the editors have very wisely secured the help of several expert chemists for the preparation of different sections of the book. The introduction (83 pages) treating of general methods of analysis and the determination of physical constants is by William A. Davis; Methyl and Ethyl Alcohol (47 pages), by G. C. Jones; Malt and Malt Liquors (32 pages), by Julian L. Baker; Wines and Potable Spirits (39 pages), by G. C. Jones; Yeast (21 pages, wholly new), by E. Schlichting; Neutral Alcoholic Derivatives, as Ether, Esters, Aldehydes, Chloroform, etc. (57 pages), by Henry Leffmann; Sugars, Analysis of Urine, Starch, Dextrin, Flour, Bread, Cellulose, etc. (180 pages), by E. Frankland Armstrong; Paper and Paper-making Materials (20 pages, new), by R. W. Sindall and Acid Derivatives of Alcohols, as acetic acid, vinegar, oxalic, succinic, malic, tartaric and citric acids (83 pages), by Henry Leffmann.

The book is one which should be in every chemical library and which no chemist engaged in the examination of foods can afford to be without.

W. A. Noyes

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VII., No. 3, issued February 26, contains the following: "The Optical Inactivity of Allantoin," by Lafayette B. Mendel and H. D. Dakin. The generally accepted formula for allantoin contains an asymmetric carbon atom. Yet examination of the substance from a variety of sources showed that it is optically inactive. Evidence is offered indicating that the phenomenon is due to tautomeric change. "The Mechanism of the Oxidation of Glucose by Bromine," by H. H. Bunzel. Experiments are described which support the view that glucose forms two series of salts: the first in which it dissociates into metal and negative glucose ions ($C_6H_{11}O_6^-$); the second, in which it dissociates into positive glucose ions ($C_6H_{11}O_6^+$) and an acid ion. Positive glucose ions are oxidized quantitatively to gluconic acid and an equation is developed showing the velocity of the reaction. "The Purine Metabolism of the Monkey," by H. Gideon Wells. The liver of the monkey resembles that of lower mammals in containing a uricolytic enzyme. The liver also contains xanthine-oxidase; the liver and other viscera contain nuclease, adenase and guanase. "The Effects of Castration on the Metabolism," by Francis H. McCrudden. An experimental study on dogs, the results of which do not confirm the view that castration is followed by a retention of material, especially mineral elements. "Chemical Analysis of Bone from a Case of Human Adolescent Osteomalacia," by Francis H. McCrudden. Bone from osteomalacia contains more magnesium and sulphur, less calcium and phosphoric acid than normal: the increase in the former is far greater than the decrease in the latter. "The Influence of Dietary Alternations on the Types of Intestinal Flora," by C. A. Herter and A. I. Kendall. Extended experiments on monkeys and cats show that an abrupt change from a dominantly protein diet to a dominantly carbohydrate diet is followed by alterations in the intestinal flora, in the putrefaction products in the feces and urine and in the clinical conditions. Degeneration of the proteolyzing bacteria takes place and they are substituted by acidophilic, non-protolyzing bacteria: marked reduction in putrefactive products in feces and urine occurs; a marked improvement in spirits and activity may be noted, indicating a greater sense of bodily and psychical well-being.

HALLEY ON THE AGE OF THE OCEAN

EDMUND HALLEY was a very great man. He was not only the first to predict correctly the return of a comet, that which is now known by his name, but also—before Newton had announced his results to any one—arrived at the conclusion that the attraction of gravitation probably varied inversely as the square of the distance. While these and other important achievements of his are well known, it seems to have been forgotten that Halley devised a method of determining the age of the ocean from chemical denudation. Indeed, I find no mention of Halley in the indices of some of the most authoritative works on geology and geochemistry, while it is evident that neither Mr. T. Mellard Reade[1] nor Mr. J. Joly[2] were aware of a predecessor in this important field. It was almost by accident that I came across Halley's paper read before the Royal Society in 1715, extracts from which are given below.

Halley recognized that the method as he proposed it was almost impracticable, but writing as he did twenty-eight years before Lavoisier's birth, he could hardly have guessed that accurate analyses of river waters, whose solvent action he so clearly describes, would ever become not merely possible but easy. It is very interesting to note that Halley's reasoning is strictly "uniformitarian" while he recognized the tendency involved to a maximum estimate.

Subject to this same limitation (extended to other features besides an original saltness of the sea), Mr. Joly's method of determining the rate at which the accumulation of salt in the ocean takes place from the analysis of

[1] "Chemical Denudation in Relation to Geological Time," 1879.

[2] *Trans. R. S. Dublin*, Vol. 7, 1899, p. 23.

river waters is perhaps the most important means now available for an estimate of the antiquity of the stratified rocks, because it is the simplest and least open to question. To my thinking the fact that his train of reasoning coincided with that of the great astronomer only adds to the credit due Mr. Joly.

A great amount of work has been done of late years on the composition of river waters, much of it incited by Mr. Joly's memoir and undertaken with the purpose of improving the data for such a determination of the age of the ocean. Within a few months it will be practicable to make known the results of a revised estimate founded upon data far more ample than those at the disposition of Mr. Joly eleven years ago. Mr. F. W. Clarke is now engaged in preparing this estimate.

The subjoined extracts from Halley's paper[3] can not but interest all lovers of natural science.

On the Cause of the Saltness of the Ocean, and of the Several Lakes that emit no Rivers; with a Proposal, by means thereof, to discover the Age of the World.

There have been many attempts made, and proposals offered, to ascertain from the appearances of nature, what may have been the antiquity of this globe of earth; on which, by the evidence of sacred writ, mankind has dwelt about 6,000 years; or according to the Septuagint above 7,000. . . . This inquiry seeming to me well to deserve consideration, and worthy the thoughts of the Royal Society, I shall take leave to propose an expedient for determining the age of the world by a medium, as I take it, wholly new, and which in my opinion seems to promise success, though the event can not be judged of till after a long period of time; submitting the same to their better judgment. What suggested this notion was an observation I had made, that all the lakes in the world, properly so called, are found to be salt, some more some less than the ocean, which in the present case may also be esteemed a lake; since by that term I mean such standing waters as perpetually receive rivers running into them, and have no exit or evacuation. . . .

Now I conceive that as all these lakes receive rivers, and have no exit or discharge, so it will be necessary that their waters rise and cover the land, until such time as their surfaces are sufficiently extended, so as to exhale in vapour that water which is poured in by the rivers; and consequently that lakes must be larger or smaller, according to the quantity of the fresh they receive. But the vapours thus exhaled are perfectly fresh; so that the saline particles brought in by the rivers remain behind, while the fresh evaporates; and hence it is evident that the salt in the lakes will be continually augmented, and the water grow salter and salter. . . .

Now if this be the true reason of the saltness of these lakes, it is not improbable but that the Ocean itself is become salt from the same cause, and we are thereby furnished with an argument for estimating the duration of all things, from an observation of the increment of saltness in their waters. For if it be observed what quantity of salt is at present contained in a certain weight of the water, of the Caspian Sea, for example, taken at a certain place, in the driest weather; and after some centuries of years the same weight of water, taken in the same place, and under the same circumstances, be found to contain a sensibly greater quantity of salt than at the time of the first experiment, we may by the rule of proportion, make an estimate of the whole time wherein the water would acquire its present degree of saltness.

And this argument would be the more conclusive, if by a like experiment a similar increase in the saltness of the Ocean should be observed: for that, after the same manner as aforesaid, receives innumerable rivers, all which deposit their saline particles therein; and are again supplied, as I have elsewhere showed, by the vapours of the Ocean, which rise from it in atoms of pure water, without the least admixture of salt. But the rivers in their long passage over the earth imbibe some of its saline particles, though in so small a quantity as not to be perceived, unless in these their depositories after a long tract of time. And if, on repeating the experiment, after another equal number of ages, it shall be found that the saltness is further increased with the same increment as before, then what is now proposed as hypothetical, would appear little less than demonstrative. But since this argument can be of no use to ourselves, it requiring very great intervals of time to come to our conclusion, it were to be wished that the ancient Greek and Latin authors had delivered down to us the degree of the saltness of the sea, as it was about 2000 years ago: for then it can not be doubted but that the difference between what is now found and what then

[3] *Phil. Trans.*, Vol. 29, 1715, p. 296.

was, would become very sensible. I recommend it therefore to the society, as opportunity shall offer, to procure the experiments to be made of the present degree of saltness of the Ocean, and of as many of these lakes as can be come at, that they may stand upon record for the benefit of future ages.

If it be objected that the water of the Ocean, and perhaps of some of these lakes, might at the first beginning of things, in some measure contain salt, so as to disturb the proportionality of the increase of saltness in them, I will not dispute it: but shall observe that such a supposition would by so much contract the age of the world, within the date to be derived from the foregoing argument, which is chiefly intended to refute the ancient notion, some have of late entertained, of the eternity of all things; though perhaps by it the world may be found much older than many have hitherto imagined.

GEORGE F. BECKER

THE NAVAL OBSERVATORY: THE COMPLETION OF THE CATALOGUE OF THE WASHINGTON ZONES OF 1846–52

SHORTLY after the founding of the Naval Observatory, the superintendent, Lieutenant M. F. Maury, U. S. N., in the spring of 1846 directed the observers on the mural circle, the meridian circle and the transit instrument, when these instruments were not otherwise employed, to determine the positions of all the stars culminating above the horizon at Washington and visible with these instruments, beginning at the southern horizon and working northward. In three years 41,700 observations had been made, covering about 30° in declination. No observations seem to have been made during the next two years, but with the installation of the chronograph observing was resumed and 3,200 observations were made during 1851–2. The total number of observations discussed in forming the catalogue is 44,900.

In 1860 was published the first volume of the zones, those observed with the meridian circle in 1846. Shortly thereafter an appropriation was secured from congress for the reduction of the zone observations and Dr. B. A. Gould, of Cambridge, Mass., was secured to take charge of the work. The observations made in 1846–9, except those already published and two books of 3,400 observations which had been mislaid, were copied from the observing books on reduction sheets which were sent to Dr. Gould. The reductions were promptly made and the printer's copy returned. Several years later, 1872–3, the results sent by Dr. Gould were published under the direction of Professor Asaph Hall, U. S. N., in three volumes, as appendices to the Washington observations.

In order to facilitate the cataloguing of these zones, a list of stars to serve as zero stars was selected and added to the observing list of the 8.5-inch transit circle by Professor J. R. Eastman, U. S. N., who also had the individual observations in the four volumes previously mentioned copied on cards. The copying on one card of all the observations of the same star was commenced when work was again stopped.

This was the state of the work in 1901 when cataloguing was undertaken by the writer. A complete rereduction of the observations has not been attempted, but a systematic search has been made for all appreciable errors. In this work have been utilized a manuscript list of 2,200 corrections by Professor J. C. Kapteyn and another of 500 by Dr. F. Ristenpart, and an effort has been made to identify each star observed but once with one in the "Cape Photographic Durchmusterung," the "Cordoba Durchmusterung" or the "Bonn Durchmusterung." All single observations not thus identified are being looked up with one of the equatorials at the observatory.

The 3,400 unpublished observations of 1847–8 and the 3,200 of 1851–2 were reduced under the direction of Professor F. B. Littell, U. S. N., in the same manner as that used in reducing the published results.

The published observations, corrected as a result of the above-mentioned comparisons, together with the unpublished ones, were compared with the positions of the "Cordoba General Catalogue" and zone corrections were determined for each night's work to reduce the Washington observations to the system of the "Cordoba General Catalogue."

After all the observations had been thus reduced the systematic difference between the "Cordoba General Catalogue" and the "Cape Catalogue" of 1850 was applied as the mean epochs of the Cape, and the Washington observations are approximately the same.

A comparison with a manuscript copy of a catalogue of the mural zones prepared by Dr. E. S. Holden and furnished the observatory through the courtesy of Dr. Holden and Professor W. W. Campbell, while disclosing a number of differences in identification, has led to only nine changes in the 8,744 observations so far compared.

A preliminary discussion of the catalogue positions gives the following mean differences between two observations.

MEAN DIFFERENCE BETWEEN TWO OBSERVATIONS IN RIGHT ASCENSION

Instrument	1846–1849 (Eye and Ear)				1851–1852 (Chronograph)	
	Number of Differences	Two Threads in Each Observation	Number of Differences	Three Threads in Each Observation	Number of Differences	Five Threads in Each Observation
		s		s		s
Mural circle	246	0.20	172	0.16	150	0.09
Transit instrument.	334	0.17	70	0.15	394	0.11
Meridian circle......	224	0.22	213	0.18	286	0.15

MEAN DIFFERENCE BETWEEN TWO OBSERVATIONS IN DECLINATION

Instrument	1846–1849		1851–1852	
	Number of Differences	Mean Difference	Number of Difference	Mean Differences
Mural circle	407	1″.5	142	2″.1
Transit instrument.	206	2.8	331	2.5
Meridian circle......	394	2.5	244	1.9

At the present time over one half of the printer's copy of the catalogue is completed. As fast as the copy is finished one set of the results is being sent to Dr. A. Auwers, of Berlin, for insertion in the "Geschichte des Fixsternhimmels." The entire catalogue will be ready for the printer in two or three months.

W. S. Eichelberger

January, 1910

THE AMERICAN SOCIETY OF ZOOLOGISTS EASTERN BRANCH

The Eastern Branch of the American Society of Zoologists met at the Harvard Medical School, Boston, Mass., on December 28, 29 and 30, 1909.

The following resolution was adopted:

Resolved (1) That the Eastern Branch of the American Society of Zoologists express its gratitude for the work of the Commission on Nomenclature of the International Zoological Congress.

(2) That it is the sense of the society that the commission be encouraged to extend its present work of deciding questions as to particular specific and generic names.

(3) That it is the sense of the society that the commission should of its own motion extend its jurisdiction to the ruling in or out of particular works of disputed status, like the Museum Bolteneanum.

(4) That in rendering decisions the commission have power to disregard the priority rule for sufficient and specified equitable reasons.

(5) That all members of this society should submit their questions of nomenclature to the international commission and abide by its decisions.

The president of the society, Professor H. S. Jennings, Johns Hopkins University, and Professor E. L. Mark, Harvard University, were appointed to act as delegates of the society at the eighth International Zoological Congress.

Officers were elected as follows:

President—Thomas H. Montgomery, Jr., University of Pennsylvania.

Vice-president—Harris H. Wilder, Smith College.

Secretary-treasurer—Herbert W. Rand, Harvard University.

Member of Executive Committee—David H. Tennent, Bryn Mawr College.

The following papers were presented:

The Segmentation of the Salpa Stolon, with some Reflections on Segmentation Generally: W. E. Ritter, University of California.

Some Problems of Cœlenterate Ontogeny: Chas. W. Hargitt, Syracuse University.

The paper briefly reviews certain facts of hydroid development brought to the attention of the society on previous occasions, and cites additional facts and observations which confirm the earlier results. Of the latter may be cited those found

to occur in the development of *Pennaria australis*, a hydroid having much in common with the local species, and corroborating its phases of development in a very remarkable degree. It may be added that these facts taken with those already known as to the perfect development of polyps from even the most erratic early cleavage leave no further room to doubt the perfectly normal character of the phenomena described.

Facts in the development of *Clava*, *Hydractinia* and *Tubularia* were also cited as confirming the previous conclusions, and thus further extending the peculiar behavior under consideration.

Associated with the above were certain inferences and reflections of considerable theoretical significance. Attention was directed especially to facts of histogenesis. It was shown that much of earlier speculation concerning this feature was tinctured with error. Later facts of hydrozoan ontogeny have not afforded any clear support of these earlier speculative contentions. Special emphasis was placed upon the fact that histogenesis in cœlenterate ontogeny is of small homological value and apparently wholly devoid of phylogenetic significance. In fact, the processes involved in the formation of the germ layers are primarily physiological and not morphological. Both ectoderm and entoderm arise thus; the first for protective and locomotor ends, the second for digestive purposes and through specific digestive or nutritive processes in the morula or planula.

The detailed paper will appear later in the *Journal of Morphology*.

Development of the Paraphysis and Hypophysis in the Alligator: A. M. REESE, West Virginia University. (Presented by title.)

The paper will be published in full in the "Smithsonian Miscellaneous Collections."

The Independent Origin and Self-differentiation of the Lens of the Eye: CHARLES R. STOCKARD, Cornell Medical School.

Normally the embryonic optic vesicle comes in contact with the lateral ectoderm of the head and this ectoderm responds to the presence of the vesicle by proliferating a mass of cells which develop into the crystalline lens. The question arises whether the ectoderm may form a lens even though the optic vesicle fails to come in contact with it, and further, what influence does the optic vesicle or cup exert over the subsequent development of the lens? The problem is more complex than it would seem at first sight and involves principles similar to those expressed in the correlation between the development of certain secondary parts and the internal secretions formed by organs on which these parts appear to depend.

By artificially suppressing and retarding the development of the optic vesicles in fish embryos I have obtained exceptional material for the study of the lens problem and from such embryos the following conclusions may be drawn.

A crystalline lens may originate from the ectoderm without any direct stimulus from either the optic vesicle or the brain tissue. The independent lens-bud is capable of perfect self-differentiation and finally becomes a refractive body identically similar in histological structure to a normal lens within the eye. The size and shape of a lens are not entirely controlled by the associated optic cup.

An optic vesicle, whether normal or defective, is invariably capable at some stage of its development of stimulating the formation of a lens from ectoderm with which it comes in contact. This ectoderm may even be out of the usual lens-forming region. Ectoderm of the head region, however, is more disposed to the formation of lenses than that of other parts of the body, as is indicated by the fact that the free lenses invariably occurred in this region.

In *Fundulus* embryos the deeply buried optic vesicles are unable to form lenses from their own tissues, although this is not true in all animals.

Further Data Concerning Twins: H. H. WILDER, Smith College.

The distinction formerly made between the two biological types of twins was reiterated, viz., duplicates and fraternals, the one presumably from the division of a single egg, after fertilization; the other from two separate eggs. Outline tracings of palms and soles of numerous individuals were presented for examination and comparison. These showed (1) that in twins of the duplicate type the main features in the configuration of the palmar and plantar epidermic ridges (friction ridges) are practically identical, and always in the case of all four sets of members; (2) that in twins of the fraternal type these features are as unlike as in any two children of one family but of different birth; and (3) that although single hands or single feet, or perhaps both hands or both feet, of two children of separate birth, especially in a large family, might be found to be as nearly alike as in cases of duplicate twins, this similarity does not extend to all four sets of chiridia, as always in these latter cases. Tracings of four sets of duplicate twins, of four

sets of fraternal twins, and of two sets of similar children of separate birth, were shown in support of the theory as stated.

Manufacture of the Squid Spermatophore: G. A. DREW, University of Maine.

Developmental Changes in Egg Substances: EDWIN G. CONKLIN, Princeton University.

In normal, living eggs of *Physa*, *Limnæa* and *Planorbis* two ooplasmic substances may be recognized, a milky or clear-gray substance, which comes to the surface of the egg at the animal pole at the time of the first maturation and which then gradually spreads over the upper hemisphere, and a yellow yolk-laden substance which is uniformly distributed through the egg before maturation, but is confined to the vegetative hemisphere after both maturation divisions. During the cleavage the clear-gray substance goes into the three quartets of ectomeres, the yellow material into the entomeres and mesomeres.

When centrifuged with a force equal to 600 times gravity for from five to twenty minutes these substances stratify in three zones, a gray zone of light substance at the central pole, a yellow zone of heavy substance at the distal pole, and a zone of clear substance, containing the nucleus, between these two.

When centrifuged before the first maturation division the proportions of these three substances are, gray one eighth, clear three eighths, yellow one half. Centrifuged just before the first cleavage, the gray and clear substances are not distinctly separated and the proportions are, gray and clear seven eighths, yellow one eighth.

Before the first maturation the centrifuged eggs orient rapidly with the yellow pole down and the gray pole up; after the maturation divisions these same eggs orient very slowly, though the gray and yellow substances remain distinct. Also eggs centrifuged after the maturation divisions orient very slowly.

Before the first maturation the gray and clear substances are finely granular, without the appearance of vacuoles or spherules, and the yellow material is coarsely granular and contains yolk spherules. After the maturation divisions the gray and clear substances contain vacuoles or spherules, and the yellow is apparently less spherular than in the earlier period.

Some of these changes may be due to the increased viscosity of the ooplasm in the later stage as compared with the earlier one, though this is not the only factor involved, since the stratification is less complete in later stages even when greater centrifugal force is used. In probably all cases there is a redistribution, to a certain extent, of the stratified substances during mitosis, but this is never complete, and the original planes of stratification may be observed for a long time during the development.

All eggs centrifuged before the first maturation division develop normally; centrifuged during the maturation divisions about one half develop normally, and one half abnormally; centrifuged at the time of the first cleavage, or just before, almost all develop abnormally. There is no evidence that this result is due to greater injury to the mitotic figure in the later stages than in the earlier ones. Embryos, otherwise entirely normal, may be produced in which the yellow and gray substances may be distributed in any axis, and even where the distribution of all the substances to the cleavage cells is abnormal and unsymmetrical, normal development may result.

Neither the yellow nor the gray substances are formative, and neither are indispensable to development. They may be distributed to the first four cells in varying proportions and yet the resulting development may be perfectly normal; either may even be thrown entirely out of the egg and yet the remainder may develop into a normal snail. The gray substance is largely of a fatty nature, the yellow contains yolk, and both may be regarded as "inclusions" in the protoplasm. On the other hand, the clear substance is indispensable to development, though it may be formed anew in cells which lack it if a nucleus is present, and this clear substance in turn contributes to the growth of the nucleus, whereas the other substances do not. Finally, the clear substance alone, of all the ooplasmic substances, increases in quantity during development. It is therefore true protoplasm. Nevertheless, normal development may result from eggs in which this substance is abnormally distributed as regards both polarity and symmetry, and in this respect it does not correspond to the "ground substance" of Lillie.

The Fertilization Membrane of Nereis: FRANK R. LILLIE, University of Chicago.

In the unfertilized egg of the *Heteronereis* found swarming at the surface of the water on moonless summer evenings at Woods Hole, there occurs a layer of coarsely alveolar protoplasm between the vitelline membrane and the yolk-bearing protoplasm. This layer, which is 6–7 μ in thickness and entirely devoid of yolk, has been called the

zona radiata by Wilson. The perivitelline space arises by the extrusion of the homogeneous contents of the alveoli of this layer through the vitelline membrane into the sea water, where it forms by swelling a layer of jelly, which may be as much as 100μ in diameter. The walls of the alveoli remain and form a protoplasmic lining of the vitelline membrane and exceedingly delicate strands of protoplasm crossing the perivitelline space. The perivitelline space is, therefore, *intraovular*.

The fact that the egg of *Nereis* thus secretes its own jelly may readily be demonstrated by fertilizing under the microscope with excess of sperm. If excess of sperm be added to closely placed eggs and a cover glass applied so as to force the eggs into a single layer, and the preparation examined with no loss of time, the spermatozoa will be seen in large numbers in immediate contact with the vitelline membrane. In one or two minutes the spermatozoa are moved away from the surface of the eggs by some invisible repelling substance, and they unite in lines that form hexagonal areas, with an egg in the center of each. The substance that sweeps the spermatozoa away from the eggs is the jelly, and synchronously with its formation the cortical layer disappears, leaving the perivitelline space crossed by protoplasmic strands as already noted.

In the case of each egg a single spermatozoon remains attached to the vitelline membrane. But this spermatozoon requires about twenty-five minutes to penetrate completely through the membrane. The stimulus to development thus precedes penetration by a considerable interval of time.

Unfertilized eggs retain the cortical layer and form no jelly, but if they are centrifuged or sufficiently stimulated with KCl the jelly forms, the perivitelline space arises and maturation takes place. KCl eggs may then differentiate further, but without cleavage.

It would appear, then, that any condition that so alters the permeability of the vitelline membrane as to permit the outflow of the alveolar contents of the cortical layer initiates development, but that the normal continuation of development is dependent on other factors.

Factors which Influence the Maturation of the Egg and Ovulation in the Domestic Cat: W. H. LONGLEY, Yale University. (Introduced by W. R. Coe.)

The course of maturation and ovulation in cats which have paired has been briefly sketched by R. Van der Stricht[1] in a preliminary paper. He finds correctly that two polar bodies are formed, the first in the ovary, and the second in the Fallopian tube, but does not note, as the case is, that the formation of the second is conditioned by the entrance of the sperm head into the egg.

The conclusions herein arrived at depend largely upon data derived from animals not allowed to pair.

Tube eggs before fertilization or in early phases of that process, that is, just after leaving the ovary, are approximate spheres. Each has a thick, tolerably uniform zona with no leucocytes or granulosa cells within it. The corona of each is highly radiate.

The study of the recently ruptured follicle shows that its epithelial lining is always very thin and the follicle just before rupture shows a high cumulus containing lacunæ.

These criteria exclude from the class of normal eggs all such as are found undergoing maturation in the ovaries of animals sexually immature, or in mature animals at the beginning of heat, or at any time during heat, if pairing does not occur. In so far, therefore, as it anticipates normal development, the maturation of the cat's egg is dependent upon pairing.

Of ten animals killed at periods ranging from 23 to 50 hours after pairing, six had already ovulated, and the one killed at 23 hours would surely have done so within the longer time mentioned. In a second series of five animals not allowed to pair, individuals were killed at 56, 73, 74 and 144 hours after first being noted to be willing to pair. None of these had ovulated, as opposed to the 70 per cent. of the first series. Still another was killed one week after the close of a period of heat of at least six days. This animal likewise had not ovulated.

The ovaries of the animal last mentioned showed three distinct series of degenerating eggs, which would easily bear the interpretation that they represented groups which had successively come to the point where they awaited the stimulus of pairing to bring about their discharge, but failing to receive it, had degenerated.

Thus in spite of the fact that Bonnet[2] has recorded a tube egg in an animal which he be-

[1] "Vitellogènese dans l'ovule de la chatte," *Ann. de la Soc. d. Med. d. Gand.*, 1908.

[2] "Beiträge zur Embryologie des Hundes," *Anat. Hefte*, Bd. IX., 1897.

lieved had been confined beyond the possibility of impregnation, from the evidence presented it would appear that ovulation in this animal, as well as in the rabbit (Heape[3]) and ferret (Marshall[4]), is strictly dependent upon pairing.

Early Maturation Phenomena in the Primary Oocyte of Sabellaria vulgaris (Verrill): H. E. JORDAN, University of Virginia. (Presented by title.)

Only ovarian and free cœlomic eggs have been studied. The material was collected at Cold Spring Harbor, L. I. The youngest oocyte, almost wholly nucleus, has a diameter of 4 microns. The diameter of the full-grown egg varies from 50 to 60 microns. Maturation proceeds to the metaphase of the first polar spindle in the ovary, after which a pause ensues until fertilization. The youngest oocytes are in synizesis. The intensely chromatic spireme is distinctly polarized. The spireme segments into a large number of V-shaped chromosomes. The shape and manner of formation of the latter suggests telosynapsis.

The chromosomes persist in various shapes through the entire growth period. The chromosomes, as arranged on the spindle, are very small and slender. As many as forty have been counted in three consecutive sections, but this may represent a second count of several. Occasionally, the chromosomes are massed close to the nucleolus before their entrance into the spindle. The spatial relationship between the chromosomes and the nucleolus appears less intimate than in several forms studied, *e. g.*, *Asterias* and *Cumingia.*

Both nucleolus and centrosomes disappear at metaphase. The cytoreticulum is coarse and its meshes are filled with spheric yolk granules. The astral rays are clearly continuous with the cytoreticulum. The evidence here favors a spongioplastic origin of the amphiaster.

The Relation of Nucleoli to Chromosomes in the Egg of Cribrella sanguineolenta (Lütken): H. E. JORDAN, University of Virginia. (Presented by title.)

The material for this study was collected at South Harpswell, Me. The full-grown ovarian egg is very large. It has an alveolar cytoplasm, and its large eccentric nucleus (diameter 300 microns) contains very numerous chromatic nucleoli of graded sizes. Occasionally it may also contain an additional very large nucleolus, the remains of the originally single nucleolus. Scattered among the nucleoli, and frequently in intimate contact with them, are a number of beaded chromatic threads of varying length, the chromosomes. The nuclear appearance suggests an amphibian egg.

The single nucleolus of the earliest stage gives origin to secondary nucleoli, apparently by a process of extrusion. These in turn produce still smaller nucleoli by a similar process. The final products of nucleolar budding are approximately equal in size to the granules of the chromosomes. The evidence indicates that the chromosomes are formed of the final products of nucleolar dispersion. The chromosomes arise from the original nucleolus or its products, at least to the extent that their chromatin content is supplied by them.

An interesting generic difference in the manner of the formation of the nucleoli obtains between *Echinaster* and *Cribrella.* In the former the single nucleolus fragments into secondary formations; in the latter the nucleolus extrudes secondary nucleoli. In the former again, the products are usually four-lobed; in the latter spheric. In an earlier study of *Echinaster* I was inclined to interpret these quadripartite bodies as chromosomes or possibly their constituent elements. In the light of facts derived from a study of *Cribrella,* it seems more probable that the several beaded chromatic threads found in *Echinaster* are also there the chromosomes. This, however, does not invalidate the conclusion that in the last analysis the chromosomes arise from the nucleolus. The four-lobed bodies more probably represent a peculiar stage in the process of nucleolar budding preparatory to chromosome formation as in *Cribrella.*

Dimegaly of the Sperm Cells of Euschistus: T. H. MONTGOMERY, Jr., University of Pennsylvania.

Experiments on the Effect of Conjugation on the Life History in Paramecium: H. S. JENNINGS, Johns Hopkins University.

Pairs that were beginning conjugation were isolated, in some cases separating the individuals before conjugation was consummated, in others allowing conjugation to occur. Both sets were then kept under identical conditions, and their reproductive powers and vitality observed. Comparison of about two hundred of those that had been allowed to conjugate and of those that had

[3] "Ovulation and Degeneration of Ova in Rabbits," *Proc. Roy. Soc. Lond.*, Vol. 76B, 1905.

[4] "The Œstrous Cycle in the Common Ferret," *Quart. Jour. Mic. Sci.*, Vol. 48, 1904–05.

not showed: (a) Those that had conjugated divided less rapidly for about a month, when the difference became equalized. In no case did those that had conjugated show a more rapid rate of fission, even after more than a month. (b) Many of those that had conjugated did not divide at all, or divided but once or twice in an abnormal way, then died. All those that had not been permitted to conjugate lived and divided normally. (c) Among those that had conjugated many abnormalities and monstrosities occurred, while none occurred among those not permitted to conjugate. Thus the experiments gave no indication of a rejuvenating effect of conjugation. It was suggested that conjugation might be preliminary to a resting condition, in which unfavorable environmental conditions are tided over.

Effect of External Agents upon Growth in Paramecium: A. H. ESTABROOK, Johns Hopkins University. (Introduced by H. S. Jennings.)

Examination was made of the growth of *Paramecium* in pure distilled water, and in solutions of sodium chloride, nicotine, strychnine nitrate and alcohol, the results being compared with the growth in hay infusion.

It was found that the cell after fission has a strong tendency to grow in a perfectly definite way, at a definite rate, the growth giving a definite curve. It thus grows in spite of the absence of any food materials; in spite of the almost complete absence of the usual salts in the water, and in spite of the presence of actively injurious chemicals that later kill the organism. Evidently inner conditions give the animal a potential of growth which it is difficult to overcome.

No evidence was found that by subjection to chemicals a race of a given type can be transformed into a larger or smaller race.

Does Lecithin Influence Growth?-A. J. GOLDFARB. (Introduced by T. H. Morgan, Columbia University.)

After referring to the chemical nature of lecithin, the speaker pointed out the rôle of lecithin in the living cell. The evidence was then reviewed upon which the generally accepted view is based that lecithin exerts a marked acceleration upon the growth of an animal.

The speaker then described his own experiments upon the same kind of animals as those used by previous investigators. Emphasis was laid upon the following: (1) the greatest pains had been taken to free the lecithin from impurities; (2) variations due to environmental factors were reduced to a minimum; (3) the large number of animals used rendered it practically certain that the resulting data did not represent individual variations; (4) the degree of variation for each kind of animal was ascertained by comparing the controls for each series and litter; (5) animals given lecithin in doses ranging from subminimal to injurious showed no definite corresponding increased growth. The utmost irregularity prevailed. Approximately one half the animals grew faster, one half slower than the respective controls. The gain was well within the normal variation.

Regardless of the kind or dose of lecithin used, or the manner of administering it, lecithin did not accelerate the growth of animals.

Is the Stimulation toward Artificial Parthenogenesis a Physical or a Chemical Process? J. F. MCCLENDON, Cornell Medical School.

I caused artificial parthenogenesis in the eggs of *Arabacia punctulata* by the following agents which stimulate muscle and produce hæmolysis: isotonic NaCl, and the following chemicals and conditions in sea water: acids, alkalis, hypertonicity, hypotonicity, ether, diminished oxygen, KCN, heat, cold, induction shocks and mechanical agitation. All of these methods probably increased the permeability of the eggs, causing a disappearance of the positive charge on the surface and thus increasing the surface tension. A band of greatest surface tension around the egg would cause cleavage, contrary to Robertson, whose experiment was vitiated by the fact that the oil drop used as a model was floating on water. I found that just before cleavage the pigment plastids migrated to the egg surface, which, if they were charged negatively, would result from the potential gradient produced at the moment the egg surface became more permeable. The fact that CO_2 and catalase come out of the egg and oxygen enters the egg, in increased amount about the time of cleavage, indicates increased permeability. The substances increasing, the permeability may enter the egg later, although their specific action was on the surface. The fact that rise in temperature causes parthenogenesis invalidates Loeb's deductions from the temperature coefficient, and the factor common to fertilization and artificial parthenogenesis is probably physical, *i. e.*, increased permeability.

The Biological Cycle of the Hay Infusion: LORANDE LOSS WOODRUFF and MORRIS S. FINE, Yale University.

The data derived from the continuous study, by means of daily counts, of the organisms of a series of hay infusions made by three standard methods were summarized. The following general observations were made:

1. The distribution of the organisms, broadly speaking, is successively at the middle, top, middle and bottom of the infusion. The distribution is determined primarily by the supply of food and oxygen.

2. The so-called cycle of organisms and their distribution is not due to inherent changes in the potentiality of division of the organisms, but to progressive changes in the environment. *i. e.*, the "cycle" is in the medium and not in protoplasmic changes of the organism.

3. Many species of infusoria do not resort to conjugation to sustain rapid cell division when the environment is slowly changing, but encyst and remain at the bottom when the conditions become somewhat unfavorable. Epidemics of conjugation usually occur when the environment is rapidly changing. Data suggest that conjugation may be a means of surviving acute changes in the environment which, for example, preclude encystment.

The fauna and flora of the infusions were studied by L. L. Woodruff and the chemical changes by M. S. Fine.

The Converse Relation between Ciliary and Neuro-muscular Movements: Alfred G. Mayer, Carnegie Institution of Washington.

Among the cations of sea water, sodium is the most potent inhibitor of ciliary activity, and the most powerful neuro-muscular stimulant.

On the other hand, magnesium is the most potent in maintaining ciliary movement, and the most powerful inhibitor for neuro-muscular movements.

Potassium in weak concentrations, such as is found in sea water, is a primary depressant for cilia, but afterwards ciliary action recovers in its presence. For neuro-muscular movements, however, it is at first a stimulant and finally a depressant.

Calcium is a weak stimulant for ciliary movement, but a depressant for neuro-muscular activity.

Ammonium at first stops and finally permits of recovery of ciliary movement, but it at first stimulates and afterwards inhibits neuro-muscular movements.

Weak concentrations of acids (H ion) at first depress and afterwards permit recovery of ciliary movement, but they at first stimulate and afterwards depress neuro-muscular movements.

In each case the effect of the salt is exerted through its cation.

We may present these results in a graphic manner if we represent a stimulus by a + sign, and an inhibition of movement by a — sign, the greater the effect the larger the print. Successive effects may be represented by a succession of signs; thus: —+ means a depression followed by recovery of movement and +— an initial stimulus followed by depression. Bearing this preamble in mind, the following table will illustrate the effects of the various cations:

Cations	Effect upon Neuro-muscular Movement	Effect upon Movement of Cilia of Animals
Sodium	+	—
Magnesium	—	+
Potassium	+—	—+
Calcium	—	+
Ammonium	+—	—+
Hydrogen	+—	—+
Lithium	+	—

Ringer's solutions, which consist of sodium, potassium and calcium chlorides, are powerful initial stimulants but finally produce depression of movement and muscular tetanus. This deleterious effect can, however, be overcome by adding magnesium, although this destroys the stimulating influence of the solution.

My experiments suggest that in surgical operations involving considerable loss of blood the Ringer's solution, which it is the practise to inject into the blood system to stimulate the heart, should be followed after recovery from the shock of the operation by a solution containing the amounts and proportions of sodium, potassium, calcium and *magnesium* found in the blood, thus counteracting the injurious after-effects of the Ringer's solution.

The Summation of Stimuli in Invertebrates: Frederic S. Lee, Columbia University, and Max Morse, College of the City of New York. (Introduced by R. C. Osburn.) The paper will be published in the *American Journal of Physiology*.

Summation of stimuli has been described in both plants and animals and is a wide-spread physiological phenomenon. It is usually ascribed

to an increase in irritability, such that a stimulus that is too weak to cause a response when applied singly, will, upon repetition, prove effective. The observations here reported were made on the muscles of certain species of invertebrates, namely, *Cyanea arctica*, *Aurelia flavidula*, *Homarus americanus*, *Carcinus mœnas*, *Cancer irroratus* and *Cancer borealis*. The major part of the work was done on *Cyanea arctica*, *Carcinus mœnas* and *Homarus americanus*, the muscles of all of which possess a marked power of summating stimuli. It was found that the irritability of the muscles can be raised by the administration to them of carbon dioxide or lactic acid in great dilution. Solutions of lactic acid of from 1/100 gram molecular to 1/6400 gm. were used, the best results being obtained by the use of 1/1600 gm. It was found possible by these reagents to change the threshold of stimulation so that a muscle responded by contractions to shocks from an inductorium which previously were unable to elicit responses. Thus by the injection in small quantities of agents which in larger quantities depress the action of muscle, it is possible to enable the muscle to respond to stimuli previously ineffective. Gotschlich found that subminimal stimulation of muscle renders it acid in reaction, even though no contractions occur. The conclusion, therefore, seems to be justified that summation of stimuli is due to a rise in irritability, brought about by the action on the living substance of small quantities of certain products of metabolism, especially carbon dioxide and lactic acid, the same substances which in larger quantities are important factors in fatigue.

Rates of Regeneration in Various Salt Solutions, and the Influence of Regenerating Tissue on the Animal Body: CHARLES R. STOCKARD, Cornell Medical School.

The processes of regenerative growth in the salamander are favorably affected by weak doses of KCl while $CaCl_2$ inhibits the rate of growth and differentiation of the part. Solutions of $MgCl_2$ also inhibit growth and differentiation, yet not so decidedly as the $CaCl_2$. Mixtures of half doses of $CaCl_2$ and $MgCl_2$ do not influence either growth rate or differentiation.

The influence of a salt solution is largely dependent upon the salt to which the animal has been previously subjected, even though some time may have elapsed since the former treatment was applied. Animals that have regenerated at a fair rate in solutions of KCl are less depressed by treatment with $CaCl_2$ than others which have not been treated with KCl.

When animals are unfed they decrease in body size. This decrease is greater in regenerating individuals, and the larger the amount of tissue an individual is regenerating the more rapidly does it decrease in size. The new regenerating tissue grows at a vigorous rate on account of its excessive capacity for the appropriation of nutriment from the old body tissues, and it is this fact that causes the body to decrease in size and become weak and emaciated. A closely similar action is seen in the behavior of certain malignant growths.

On the Structure and Regeneration of the Epidermal Layer in some Siliceous Sponges: H. V. WILSON, University of North Carolina. (Presented by title.)

The epidermal layer in two monactinellid sponges (*Stylotella* and *Reniera*) was studied. Various histological methods were employed. The epidermis does not consist of flat epithelium cells (pinacocytes), but is a continuous, thin sheet of protoplasm studded with nuclei and entirely without cell boundaries. It is a syncytium.

The pores are the superficial apertures of very short canals (pore-canals) which perforate the dermal membrane. Closure of the pore is brought about by an extension (pore-membrane) of the thin epidermal layer over the pore-canal. The pore-membrane in *Stylotella* from the start is continuous and diaphragm-like. In *Reniera* the pore-membrane in the early stages of pore-closure exhibits active, amœboid changes of shape and position.

In *Stylotella* a new epidermis develops over a cut surface in the course of a day. It is formed by the cells of the mesenchyme, which are already interconnected by slender processes. The mesenchyme cells crowd to the surface and flatten out. At this time they are close together and connected by a reticulum of delicate, protoplasmic strands. Union between the cells then becomes perfect, their boundaries disappearing.

Wound Reparation and Polarity in Tentacles of Sagartia: HERBERT W. RAND, Harvard University.

If a distal piece is cut from a tentacle of *Condylactis* or other large actinians, the wall at the cut edge of the stump immediately bends inward slightly. Then a broad zone of wall at the cut edge contracts until its lumen is obliterated, so that the distended stump, now functionally

closed, bears a conspicuous projecting cylindrical "nipple." Within two days the contracted zone gradually relaxes, the nipple disappears, and the end becomes structurally closed.

The relatively very small tentacles of *Sagartia luciæ* show similar behavior, but the structural closing is accomplished within six hours.

Sagartia was kept in a solution of chloretone such that all muscular activity was suspended during eight hours. The initial inbending at a distal cut edge nevertheless took place. But the zone of wall which ordinarily contracts to form the nipple did not contract; no nipple was formed. *A steady centripetal movement of uncontracted tissue at the cut edge occurred until within eight hours the cut end was structurally closed.*

The temporary nipple, therefore, results from muscular contraction, but the definitive closing depends upon non-muscular activities which effect a spatial readjustment of the tissues near the cut edge.

The regions of a tentacle which are proximal and distal with reference to a plane of cutting or the point of application of a tactile stimulus differ markedly in their immediate reactions to the cutting or the tactile stimulus. The form assumed by a proximal cut end is distinctly different from that of a distal cut end. In these respects the *Sagartia* tentacle tissues, like those of *Condylactis*, show a distinct polarity which is not explicable upon the basis of their known structure.

The Regulation of the Water Content in Regeneration: SERGIUS MORGULIS, Harvard University. (Introduced by E. L. Mark.)

An examination of the water content at successive stages of regeneration in a polychæt, *Podarke obscura*, showed that the percentage of water rises rapidly soon after the operation, reaching a maximum between the first and second weeks, approximately at the time of highest regenerative activity; subsequently it begins to decline. In this respect (rise and fall of the percentage curve of water) regeneration is essentially like embryonic growth. But while in embryonic growth the increase of the percentage of water is due to imbibition of water from the surrounding medium, this, apparently, is not the case in regeneration.

The regenerating worms, whether fed or starved, are losing in weight, and three phases of regulation of the water content in the organism may be distinguished during the process. At first there is rapid loss in weight, but proportionally more dry substance than water is lost, the percentage of water rising. Then follows a period of rather slow diminution in weight, when practically no water is being lost, the content of water attaining its maximum. Lastly, comes a period during which proportionally more water than dry substance is being lost, the percentage of water thus declining.

The Behavior and Structure of a New Species of Gregarine: R. A. BUDINGTON, Oberlin College.

The form described occurs in the alimentary tract of the barnacle, *Balanus eburneus*. It is of the polycystid plan of structure, and is conspicuous for the rapidity and complexity of its movements. Prolonged progression in a straight line, flexures and torsion of the body, movements of the protomerite in all planes independently of the rest of the body, are specially noticeable. Disturbances in the environment of the animal during its progression do not seem to be accounted for on the basis of either Schewiakoff's secretion theory or Crawley's epicytic undulations.

The nucleus, both while living and when stained "intra-vitam" and after fixation, shows an average of about five very distinct karyosomes ("prochromosomes"). Bodies of precisely similar appearance and which react similarly to nuclear stains are present in the protomerite; and since the wall of separation between proto- and deutomerite is complete, the chromatin content of the former, though not contained within an organized nuclear wall, make it in certain ways essentially a separate cell.

The Function of the Ear in Cyclostomes: G. H. PARKER, Harvard University. (Presented by title.)

Within recent years evidence has been brought forward to show that killifish, goldfish, squeteague and dogfish can hear. No tests have been made on cyclostomes. As their ears are the most primitive in all the vertebrates, they were tested for hearing. Ammocœtes will rest quietly on the padded bottom of a wooden aquarium. When the side of the aquarium is struck by a heavy, swinging pendulum, the fish usually responds by a winking movement of the oral hood and by curving the body. After the eighth nerves are cut, these responses are called forth only by a blow three or four times as strong as that necessary to stimulate the normal animal. When only one nerve is cut, the fish responds in a normal manner. These observations show that the cyclostomes are responsive to sound, not only through the skin, but also through the ear.

The Morphology of the Swim-bladder in Teleosts: HENRY C. TRACY, Brown University. (Introduced by A. D. Mead.) (Presented by title.)

The most important types of swim-bladders are, first, primitive swim-bladders with an open pneumatic duct and undifferentiated epithelial lining, and, second, the highly specialized type without duct but with the so-called "oval" on its dorsal wall.

Two exceptional types are probably to be considered transitional forms. One is the swim-bladder of the eel; the duct is enlarged into a capacious chamber, but its œsophageal connection is much reduced. The duct is lined with flat epithelium under which is a *rete mirabile*.

The other transitional type is found in toadfish (*Opsanus*) and a few other forms. It has lost its œsophageal connection, but is divided into an anterior and a posterior chamber by a transverse partition, through which is a round opening. The structure of the walls of the posterior chamber is like that of the duct of the eel. This chamber develops directly from the embryonic pneumatic duct.

From the posterior chamber of the swim-bladder of the toadfish the transition to the oval may be considered to have taken place by an approximation of the partition to the posterior wall of the organ. The red gland develops by a progressive differentiation of the epithelial lining.

Ciliation of the Palps of the Acephala: J. L. KELLOGG, Williams College.

The known function of the ciliated inner surfaces of the palps of bivalves is to transport food particles from gills to mouth; but they have been found also to possess the power of directing undesirable materials, such as mud, on to ciliated tracts that carry them out of the body.

The inner palp surfaces are found to possess four distinct currents: one across the folds to the mouth; a second in the opposite direction, on the ventral palp margin; a third set of tracts on the faces of the palp folds, from their ventral to their dorsal ends; and a fourth set, deep in the grooves between folds, from dorsal to ventral ends.

The function peculiar to each of these was fully determined during the past summer in several of the large forms of Puget Sound. That of the fourth set is especially interesting. These tracts are entirely covered when the animal is feeding. They are exposed by a peculiar movement of the folds when a large quantity of material is brought to the palps, as is the case in muddy water, the entire mass being led to tracts that convey it from the body. The fate of particles brought to the palps is determined not by their nature—whether suitable for food or not—but solely by their volume.

Parallel Development in Tropical Trematodes: H. S. PRATT, Haverford College.

The digenetic trematodes as well as other internal parasites have probably in their phyletic history followed somewhat different rules of descent from those of other animals. The fact that they live inside of other animals and have also a very complex life history must affect their phyletic development most profoundly, and in two ways: (1) The possibilities of migration are very much limited. (2) The environment of the parasites being extremely uniform and subject to relatively little variation there is a corresponding uniformity of structure in the parasites themselves. Thus we see that although there are several thousand species of digenetic trematodes in existence living in all parts of the world they are astonishingly alike in structure—so much so that until quite recently all of the thousand or more species of distomes were included in the single genus *Distomum*. The monogenetic trematodes, on the other hand, which are external parasites and have consequently a very much simpler life history and a much more varied environment show a much greater variety of structure, although they count fewer species.

These facts make it probable that where there are apparently related species of digenetic trematodes living in widely separated localities the fact that they possess the same or similar structural features does not necessarily indicate that there is a close genetic relationship between them. They have not necessarily inherited their peculiarities from a common ancestor even when they are so much alike that they are classified in the same genus. But they are undoubtedly in very many cases descended from different ancestors and have reached their present structural condition by traveling along parallel or converging lines of descent.

These facts are well illustrated by the several species of digenetic trematodes belonging or allied to the genus *Helicometra* which were found in certain fishes in the Gulf of Mexico at Tortugas, Florida, and also occur in the Mediterranean Sea. That the species of this peculiar genus are thus taken as an indication, not that they necessarily bear a close genetic relationship to one another,

but that similar or identical environmental conditions exist for them in these places, so that they have come to possess in the course of time a structure so similar that they are included in one and the same genus.

A New Rhabdocœle, Commensal with Modiolus plicatulus: EDWIN LINTON, Washington and Jefferson College. (Presented by title.)

In searching for rediæ in a lot of mussels at Woods Hole in July last a small worm .2 mm. in length was found by the writer which at first was taken to be a redia with numerous cercariæ already active within it. On subsequent dates others were found. They proved to be turbellarians belonging to the genus *Graffilla*.

The species is viviparous, at least in July and August.

All stages of development, from the germ cells in the ovary-vitellarium to active ciliated young with black eye specks, may be seen in the same adult worm. There is a singular lack of uniformity in the details of development, although the outcome as a rule is the development of a pair of young worms within the same egg-membrane.

The worms are active, but move for only a short distance before changing their direction. They tend to move away from the light.

Their distribution is dependent on local conditions. They were not found in mussels which grow on confined coves or marshy places. The best localities for finding them are those which are exposed only at very low tides and where there is rather free tidal movement.

The Inadequacy of the Law of Priority, with a Suggestion for Relief: J. S. KINGSLEY, Tufts College.

Characteristics of the Diverse Races of Paramecium: H. S. JENNINGS and GEO. T. HARGITT, Johns Hopkins University.

Jennings has described the existence of a number of diverse races in *Paramecium*, differing constantly in size. The junior author of the present paper undertook a cytological study of six of these races, in order to determine their relation to the supposed species, *Paramecium caudatum* and *Paramecium aurelia*. It was found that two sets of races could be distinguished, one set having two micronuclei, the other but one. The races with two micronuclei were all smaller than those with one. The larger races together thus correspond with what had before been described as *P. caudatum*, the smaller races with *P. aurelia*. The two differ also in the size, position and staining relations of the micronuclei, in ways that correspond to the descriptions of Hertwig and Maupas. But *in rare cases* specimens of the *caudatum* races have two micronuclei, those of *aurelia* races but one, thus confirming the observation of Calkins on this point. The races have remained constant in size in the laboratory for between two and three years. They differ from each other (even within the *aurelia* or *caudatum* group) not only morphologically, but physiologically, especially in their relation to conjugation. It has not thus far been possible to cause the members of one race to conjugate with those of another.

The Pearl Organs of American Minnows in their Relation to the Factors of Descent: JACOB REIGHARD, University of Michigan.

Pearl organs are horny, conical epidermal upgrowths which occur in males and are functional only during the short breeding season. Extensive observation of the breeding activities of many species has made known in detail the *whole utility* of these organs to the species. They serve chiefly to roughen the skin and enable the male to retain his hold of the female during the brief spawning act.

In form, size and distribution they afford characters by which even the species of a subgenus are easily separable. In general the spawning attitudes of males of different species are such as to bring their roughened surfaces into contact with the female and a Lamarckian or Darwinian interpretation of the origin and differentiation of the pearl organs is thus suggested. Since the number of spawning attitudes is far fewer than the specific distributions of the organs concerned, the one could not have arisen in correlation with the other. From this fact and others it is concluded that the origin and specific distribution of the pearl organs must have come about without reference to utility and through internal forces. Use differences are here superimposed on structural differences in such way that no specific correlation exists between the two.

The Causes that Determine the Fauna and Flora of the Small Islands of the New England Coast; a Study in Natural Selection: A. E. VERRILL, Yale University.

Abnormal Individuals of Didinium nasutum and their Bearing on the Question of Natural Selection: S. O. MAST, Goucher College, Baltimore. (Presented by title.)

In large vessels containing cultures of *Didinium*

one occasionally finds specimens with two or three oral ends and several bands of cilia, but never any which are more abnormal. Each oral apparatus is functional in these creatures. I have seen specimens swallow three paramecia at a time. If they are isolated and kept in shallow dishes with plenty of paramecia they thrive and reproduce rapidly. Ordinarily normal specimens are cut off at each oral end and the original individuals remain as they were, but in some cases there is a tendency to form more complicated abnormalities due to incomplete fission.

Many of these are unable to swim and consequently lie on the bottom. If there are numerous paramecia and the water is shallow, they persist indefinitely, and many abnormal specimens are formed as well as normal ones. Under natural conditions, however, such specimens are at once eliminated, for they sink to the bottom while the paramecia on which they feed remain near the surface. Natural selection is thus seen to operate in preventing the perpetuation of these monsters.

Variation in Urosalpinx: H. E. WALTER, Brown University.

Over 50,000 shells of the oyster drill, *Urosalpinx cinereus*, which were collected at various times between 1898 and 1908 from various localities both on the Atlantic and Pacific coasts, were carefully measured and the variation, as shown by standard deviation, computed. So far as the statistical method is able to reveal, it is extremely doubtful whether or not this mollusk when introduced into a new habitat, as happened when they were accidentally transplanted with oysters to the Pacific coast from the Atlantic, exhibits greater variability than in its new habitat. The change of variability appearing in successive fortnights in shells in the same locality, as well as the change showing itself in the August shells of the same locality for successive years, is pronounced enough to indicate plainly the working of an ontogenetic variability independent of environmental modification, that is, a time factor as distinguished from a place factor. In consequence of this, it is practically impossible to collect homologous lots of these shells upon which the place (or environmental) factor may be accurately determined.

Some Results of a Study of the Inheritance of Barring in Poultry: R. PEARL and F. M. SURFACE, Maine Agricultural Experiment Station.

Certain results obtained by reciprocally crossing Barred Plymouth Rock and Cornish Indian Game fowls were described. It was shown that the barred plumage pattern is inherited in these hybrids in a sex-limited manner. The cross Barred Plymouth Rock ♂ × Cornish Indian Game ♀ gives all barred offspring, in both sexes. The reciprocal cross gives barred males and solid black females. It was shown that the degree or intensity of pigmentation (apart from pattern) is not inherited in these hybrids in the manner to be expected if there were a simple blending of the degrees of this character manifested in the parents. The complete paper will shortly be published elsewhere.

Ophiurans and "Jordan's Law": HUBERT LYMAN CLARK, Harvard University.

The study of a large collection of ophiurans from the North Pacific Ocean has shown that closely related species are often found occupying the same area. In several instances, a given species was taken two or more times, in the same trawling, with its nearest known ally. These facts are counter to that principle of the extreme importance of geographical isolation which has recently been formulated and designated as "Jordan's law." An illustration of a form of physiological isolation was offered, found among West Indian ophiurans, which suggests a possible reason why geographical isolation is relatively unimportant in the class.

On the Geographic Distribution of some Pelagic Organisms: H. B. BIGELOW, Harvard University.

The Distribution of Flies in Providence: G. F. SYKES, Brown University. (Introduced by H. E. Walter.)

During the summer of 1909 a series of investigations was begun in Providence, R. I., for the purpose of ascertaining the actual importance of the "house flies" as a factor in the spread of enteric diseases. The following results were obtained: (1) the fly nuisance is local; (2) the geographic distribution of pestiferous flies is determined by local sanitary conditions; (3) the seasonal distribution is conditioned by meteorological influences (temperature and sunshine); (4) over 99 per cent. of all the flies caught (in three kitchens) were *Musca domestica*, the remaining fractional per cent. were *Lucilia cæsar;* (5) the plotted curve for typhoid cases did not show a close relation to the fly curve, but did show a close parallel to the temperature curve; (6) the high-water mark for deaths from diarrhœa antedated that for the fly season by fully three weeks, and followed from one to two weeks after a noticeable

rise in temperature; (7) the geographical distribution of typhoid cases over the city was largely independent of areas known as "unsanitary" and as "fly centers."

The conclusions drawn from these results point toward a more fundamental factor than the house fly in the spread of enteric diseases. Furthermore, judging from the constant relationship which the temperature curve maintained through the experiment, it is not unnatural to suppose that therein lies the solution of the problem; but whether the influence of temperature is real or only apparent, direct or indirect, remains yet to be determined.

The Leaping of the Pacific Salmon: Henry B. Ward, University of Illinois.

Observations made, chiefly in southeastern Alaska, on the red and humpback salmon indicate that the fish do not choose a particular point of attack in endeavoring to surmount a fall. The height and length of the jump were very variable and on the whole there appeared to be a remarkable lack of accuracy as well as of definiteness in the movement. This apparent aimlessness of the leaping may be the result of a fairly precise response to definite stimuli in the water currents which in the small whirlpools below the falls are subject to constant and unexpected changes. When endeavoring to surmount the falls the fish sail through the air with body rigid and fins spread tense, while at the instant when the momentum of the jump is lost one notes a series of rapid and powerful vibrations of the tail; these are made regardless of the success of the jump or of the position of the fish in air or in water. If the fish reaches solid water at the crest of the fall, they insure the maintenance of the vantage thus gained.

The open water jumping is of a distinct type, since the body leaves the water sidewise instead of in a vertical position, the musculature is somewhat relaxed and the fins are partly folded backwards, while finally there is no movement of the tail at the close of the jump. The purpose of this jump is not clear.

Direction of Locomotion of the Starfish (Asterias forbesii): L. J. Cole, Yale University.

It was shown that in the absence of directive stimuli, although starfishes might move with any ray in advance, in a large number of trials it was most often the one lying next to the left of the madreporic plate which went ahead. This may perhaps then be considered the *physiological anterior* of the animal. Attention was called to the fact that in the bilateral echinoids, the spatangoids, it is similarly the ambulacral area to the left of the madreporite which is anterior.

Reactions of Echinoderms to Light: R. P. Cowles, Johns Hopkins University. (Presented by title.)

A review of the literature dealing with the reaction of starfishes to light shows there is a general belief that these animals depend for their responses to light upon the eye spots situated at the tips of the rays. Some authors even state that certain starfish do not react to light when these organs are removed.

While experimenting with the starfish, *Echinaster crassispina*, the writer found that the eye spots may be removed and that the creature may still react to differences in the intensity of the light. The tips of the rays of several echinasters were amputated and these starfish were then tested in a rectangular glass dish lined with dead black paper and filled with sea water. The dish was placed in a black-lined box with a single opening at one end through which bright daylight was allowed to enter. When a series of tests were made the starfish was placed in the dish, care being taken to vary the manner of handling and also to vary the position of the rays with reference to the source of light. In the majority of tests the echinasters moved to the lighter end of the dish, although the reaction was somewhat slower than with normal individuals.

Reactions of Amœba to Light: S. O. Mast, Goucher College, Baltimore.

If direct sunlight is flashed on an active specimen of *Amœba proteus* all movement stops immediately. The pseudopods remain just as they are, without contracting, until after the lapse of a few moments, when new ones are thrown out, usually at the posterior end. Then the old ones gradually disappear. This occurs in the blue of the solar spectrum nearly as definitely as in white light. Green is much less effective; violet, yellow and red have scarcely any effect.

When an amœba comes in contact with a well-defined area of light composed of rays perpendicular to the slide, it usually stops and proceeds in a different direction.

In a horizontal beam of direct sunlight they orient fairly accurately. Changing the direction of the rays produces a change of intensity on the surface, but this causes no apparent retardation in any pseudopods. Nor does difference in light

intensity on opposite sides of a pseudopod induce difference in rate of streaming so as to cause it to bend. Orientation is due to the inhibition of the formation of new pseudopods on the more highly illuminated side of the body of the amœbæ, not to any effect on those already formed.

Colored Lights of Equal Intensity for Biological Work: G. H. PARKER and E. C. DAY, Harvard University. (Presented by title.)

Colored light was produced by passing the light from a Nernst lamp through a solution of an appropriate aniline dye contained in a plate-glass cell and used as a screen. In this way blue, green, yellow and red lights of fair spectroscopic quality were obtained. The intensity of these lights was measured in terms of energy (heat) by means of a radiomicrometer which was accurate to within 2 per cent. The stronger lights were then reduced by being placed at such distances from the animals experimented upon that all lights were of equal intensity at the spot where the animals were. It was proposed to extend this method to spectral light.

Notes on the Behavior and Reactions of Amphioxus: L. HUSSAKOF. (Introduced by Bashford Dean, American Museum of Natural History.)

These experiments were carried on at the Naples station during last September. They dealt with the behavior of amphioxus and its reactions to light, heat, chemical and mechanical stimuli. In some reactions the Neapolitan species, *Branchiostoma lanceolatum,* behaves differently from the Bermuda form, *B. caribbœum,* notably in regard to heat. The former is adapted to a temperature ranging from 35° C. to —.5° C., while the latter (as shown by Parker) will survive only within the limits of 42° C. and 4° C.

The Movements of the Earthworm—A Study of a Neglected Factor: SERGIUS MORGULIS. (Introduced by G. H. Parker, Harvard University.)

While studying reflex reactions of the earthworm I have been impressed with the fact that the worm tends to move in a straight direction, and, once having assumed such a course, it maintains itself obstinately in the path. This simple observation was substantiated by special experiments where, with the aid of an apparatus constructed for this purpose, the anterior or posterior part of the worm was deflected either to the right or to the left from the straight course. By turning the tail to the right, for instance, the head would be caused to turn to the left, and *vice versa.* The position of the tail could be changed several times successively, first to the right, then to the left, etc., and the head would likewise change its position but in an opposite direction. The extent of the orientation reaction of the head was found to be directly proportional to the length of the posterior part of the worm deflected from the straight course; while the degree of deflection of the posterior part necessary to occasion a bending of the head in an opposite direction is inversely proportional to the length of this part. Depending upon the relative position of its tail, the earthworm responding to unilateral stimulation turns either towards or away from the stimulus until it has assumed a straight position, and then it begins creeping in that direction.

The Leucocyte Content of Milk: R. S. BREED, Allegheny College.

Studies upon the Nerve Cells of Invertebrates: W. M. SMALLWOOD and C. G. ROGERS, Syracuse University.

The nerve cells of all invertebrates so far examined, including representatives of more than twenty genera of molluscs, worms and crustacea, contain pigmented or unpigmented solid granules of various sizes.

The same nerve cells show also the presence of many vacuoles, containing a transparent liquid. These may be very abundant and are located principally in the outer zone of the cytoplasm.

The vacuoles represent granular deposits which are in process of transformation, so as to furnish energy for the work of the cells.

Excessive work upon the part of the cells, starvation, etc., serve to bring about the destruction of the granules, and their replacement by vacuoles. The granules may, therefore, be considered to be storage material which may be called upon at any time of special stress to furnish energy for the work of the cells.

Some Observations on the Behavior of the Beach Flea, Orchestia agilis: A. M. BANTA. (Introduced by C. B. Davenport, Carnegie Institution, Station for Experimental Evolution.)

When disturbed by lifting the eel grass the animals are largely negative to light. In a few minutes if prevented from concealing themselves they become positive and remain so if the intensity of light remains constant or is increased. If the intensity is materially decreased, however, the orchestias become *negative.* This is a most exceptional reaction. With most organisms, if there is a reversal of the light reaction with change in intensity, the negative reaction is to

the higher intensity and the positive to the lower intensity. When thus made negative to dim light *Orchestia* becomes again positive if exposed to strong light. Kept in dry air, the animals become negative. After retention in darkness they are positive. Placed in water they are negative.

A number of these reactions are of evident importance in the animal's daily movements. The reversal from positive to negative with decrease in illumination aids in directing the animal's movements in reentering the eel grass, as likewise does the negative reaction when becoming too dry. The animal's negativity when in water aids it in reaching shore when overtaken by the tide, the shore line serving as a dark region as compared with the equally illuminated expanse of water in all other directions.

On the Transition from Parthenogenesis to Gamogenesis in Aphids and Braconids: S. J. HUNTER, University of Kansas.

Continuous experimental study since May, 1907, on the aphid, *Toxoptera graminum*, has brought out the following regarding the development of aphids as illustrated by this species:

Parthenogenetic forms appear during the spring, summer and early fall. These forms may be winged or wingless, the latter greatly predominating. The characters of each remain constant until about October 1, when, as first observed by Glenn in this laboratory, these parthenogenetic forms begin to produce intermediate forms varying in structure between the winged parthenogenetic form and true female on the one side and the wingless parthenogenetic form and true female on the other side. Within the bodies of these intermediate forms appear, in some live young, in others winter eggs, in still others both winter eggs and living young. All such intermediate forms, however, die without producing offspring or eggs, as do many of the apterous parthenogenetic individuals belonging to the sexual generation.

These intermediate forms seem to be parthenogenetic individuals affected by the stimuli which bring about the transition from parthenogenetic females to the true sexes. In some the reproductive organs are unmodified, in others they approach the true female type to a greater or less degree. These intermediate forms belong to the sexual generation and may be considered as an attempt toward the development of the sex individual. They play no part in the life of the insect.

The parent of these intermediate forms and of the true female may be either winged or wingless. The males have no intermediate forms and are uniformly the offspring of the wingless parthenogenetic females. One single parthenogenetic wingless individual has been observed to produce types of all the above described forms. The above intermediate forms together with the appearance of the true sexes occur only during October, November and December regardless of the conditions under which the various experimental stocks are kept throughout the year and without reference to the number of generations.

Young growing wheat has been the uniform food plant throughout the entire period of experimentation.

In the braconid, *Lysiphlebus tritici*, a parasite of *T. graminum*, gamogenesis occurs in nature. In one count of a thousand insects taken in the field 5 per cent. were males, in another 35 per cent. By isolation of virgin females in fourteen experiments all offspring were males, and in seven experiments 1 out of 26, 4 out of 27, 3 out of 17, 1 out of 22, 1 out of 18, 1 out of 12, 2 out of 27 were females, making a total for the twenty-one experiments of 339 males and 13 females. In an extensive series of subsequent experiments no females have appeared. Of these parthenogenetic forms it is worthy of note that 203 of the males had 15-jointed antennæ, 131 had 14-jointed antennæ and 5 had 16-jointed antennæ. Of the 13 females, 8 had 13-jointed antennæ and 5 had 12-jointed antennæ. Gamic females show the same conditions, but among gamic males no 16-jointed forms have been found. Polyembryony does not occur in this parasite.

Proliferation of Eyes in an Abnormal Tentacle of a New Species of Marine Gasteropod: F. N. BALCH. (Introduced by G. H. Parker.)

In the unique specimen of *Onchidiopsis corys* sp. nov. the left tentacle is bifid, the internal, or mediad, member appearing nearly normal and bearing a normal eye. The external member is abnormal in size and shape, is folded backward, bears on the surface thus exposed (but morphologically mediad) a normal-appearing eye, and if folded forward into its true morphological position would be the mirror-image of the internal member. On sectioning, the bifid tentacle is seen to bear two encysted parasites, probably cercarian. The "eye" in the external member is seen to consist of a group of four eyes apparently proliferating one from another and constituting one series of three "generations," and another junior

series of two, the largest eye being common to both series. All these eyes are complete in all their parts (lens, retina, etc.), though differing greatly in size, development of optic nerve and degree of external abstriction. All are internally completely occluded except the least developed, which still connects by a lumen with its "parent" eye. The growth is orderly in that it secures (*a*) the same axial orientation, (*b*) the same polar orientation, (*c*) freedom from mutual interruption of vision, (*d*) nearly maximum compactness. No other possible arrangement secures all these. The mass of tissue in the group is greater than in the normal eye. The case is unique in the literature. The possibility that it represents not proliferation but unequal development of the fragments of a broken-up *anlage* is admitted, but rejected as a probability. If a true case of repetitive proliferation of such specialized structures as these eyes, then near analogies are lacking.

The following exhibits were presented:

Inheritance of Color in the Common Clover Butterfly (Colias philodice): (a) 125 Descendants (F_1 and F_2) of a White Female. (b) Offspring of an Aberrant Female of the Spring Brood, resembling the Arctic Species (Colias nastes, Boisd.): J. H. GEROULD, Dartmouth College.

Cytological and Other Characteristics of the Diverse Races of Paramecium: H. S. JENNINGS and G. T. HARGITT, Johns Hopkins University.

Specimens of the 1,500th Generation of Paramecium, attained without Artificial Stimulation or Conjugation: L. L. WOODRUFF, Yale University.

HERBERT W. RAND,
Secretary

HARVARD UNIVERSITY

THE ASSOCIATION OF OFFICIAL SEED ANALYSTS

THE second annual meeting of the Association of Official Seed Analysts was held in Boston, December 28–29, 1909, in connection with the meeting of the American Association for the Advancement of Science.

Agricultural colleges, experiment stations and state departments of agriculture in twelve states and the Canadian and the United States departments of agriculture were represented.

Three papers were presented as follows:

"The Effect of Alternating Temperature on the Germination of Seeds," by W. L. Goss, U. S. Department of Agriculture.

"Importance of Uniform Methods of Seed Testing," by A. D. Selby, Ohio Agricultural Experiment Station.

"The Sale of Adulterated Farm Seeds in the United States," by E. Brown, U. S. Department of Agriculture.

The greater part of the time of the meeting was devoted to consideration of the reports of the committees on methods of seed testing and on legislation. The report on methods of seed testing for purity was adopted as official by the association and that on germination as provisional. The report on state legislation was adopted and the secretary was instructed to prepare both reports for publication.

E. BROWN,
Secretary

SOCIETIES AND ACADEMIES

THE THIRD ANNUAL MEETING OF THE ILLINOIS STATE ACADEMY OF SCIENCE

IN attendance, number and character of papers presented, and in the general spirit of enthusiasm and interest, the meeting at Urbana, February 18 and 19, is regarded with great satisfaction by those who had the good fortune to be present.

More than one hundred new members were elected, so that now the academy, while but three years old, has something more than four hundred names enrolled on its list—a fact which speaks well both for the enthusiasm and the spirit of helpfulness of Illinois men of science, and which repudiates the idea that men of science are recluses.

About one hundred and fifty people were present at the various meetings.

The program was as follows:

"Dr. A. W. French," In Memoriam, A. R. Crook.

"A Needed Piece of Work in the Interest of our Young Investigators in Biology," T. W. Galloway.

"The Vegetational History of a Blowout," H. A. Gleason. (Lantern.)

"Recent Habitat Changes in the Illinois River," Chas. C. Adams. (Lantern.)

"Forest Successions on Isle Royale," Wm. S. Cooper. (Lantern.)

"An Ecological Study of the Fish of a Small Stream," Thomas L. Hankinson.

Address of welcome by the president of the University of Illinois.

Presidential address—"Relations of the Illinois Academy of Science to the State," Stephen A. Forbes.

"Informal Account of my Recent Oriental Trip," T. C. Chamberlin.

Reception given by the Illinois Chapter of Sigma Xi.

Symposium—

(*A*) "The Relation of Pure and Applied Science to the Progress of Knowledge and to Practical Affairs":

In Biology, Cornelius Betten, Lake Forest College.

In Chemistry, Julius Stieglitz, University of Chicago.

In Physics, John F. Hayford, Northwestern University.

(*B*) "The Relation of Pure and Applied Science to Secondary Education," C. G. Hopkins, University of Illinois, and Worrallo Whitney, Bowen High School, Chicago.

"The Passing of our Game Birds," Isaac E. Hess.

"Further Studies on the Influence of Copious Water-drinking with Meals," P. B. Hawk.

"Biology and other Sciences as applied by a Breeder," Q. I. Simpson.

"Report on the Ecology of the Skokie Marsh Area near Chicago, with special reference to its Mollusca," Frank C. Baker. (Lantern.)

"Ecological Succession of Fish and its bearing on Fish Culture," V. E. Shelford. (Lantern.)

"Forest Associations of Northwestern Illinois," H. S. Pepoon.

"Relic Dunes," Frank C. Gates. (Lantern.)

"On the Relation of the Jeffersonville Beds of Indiana to the Grand Tower (Onondaga) Limestone of Illinois," T. E. Savage.

"Observations on the Earthquake in the Upper Mississippi Valley, May 26, 1909," Johann August Udden.

The officers for the ensuing year are:

President—John M. Coulter, University of Chicago.

Vice-president—R. O. Graham, Illinois Wesleyan University.

Secretary—A. R. Crook, State Natural History Museum.

Treasurer—J. C. Hessler, James Millikin University.

Third Member Publication Committee—H. H. Stoek, University of Illinois.

Membership Committee—Fred L. Charles, University of Illinois; Thomas L. Hankinson, Eastern Illinois State Normal; V. E. Shelford, University of Chicago; W. E. Tower, Englewood High School; Isabel Seymour Smith, Illinois College.

Committee on Ecological Survey—Stephen A. Forbes, V. E. Shelford, H. A. Gleason, E. N. Transeau, Frank C. Baker, Charles C. Adams.

Committee on Deep Drilling—J. A. Udden, U. S. Grant, Frank DeWolf.

Committee on Assistance of the Academy to High Schools in Science Teaching—C. J. Hopkins, John F. Hayford, John G. Coulter, Worrallo Whitney, W. S. Strode.

Committee to Influence Legislation in favor of increased Protection for Game Birds—Stephen A. Forbes, John M. Coulter, A. R. Crook, J. C. Hessler.

Committee to Influence Legislation to restrict the Collection of Birds and Eggs solely to Accredited Institutions—F. C. Baker, I. E. Hess, F. L. Charles.

Committee to cooperate with existing Agencies for the Advancement of Nature-study in Elementary Schools—Fred L. Charles, Ira Meyers and Ruth Marshall.

A. R. Crook,
Secretary

Springfield

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and forty-seventh regular meeting of the society was held at Columbia University on Saturday, February 26, 1910, twenty-eight members being in attendance. Ex-president W. F. Osgood occupied the chair at the morning session, Vice-president J. I. Hutchinson at the afternoon session. The council announced the election of the following persons to membership in the society: Mr. E. S. Allen, Berkshire School, Sheffield, Mass.; Mr. B. A. Bernstein, University of California; Mr. G. W. Evans, Charlestown High School, Boston, Mass.; Mr. C. E. Flanigan, Wheeling, W. Va.; Mr. C. E. Githins, Wheeling, W. Va.; Mr. J. S. Mikesh, University of Minnesota; Professor G. P. Paine, University of Minnesota; Mr. W. L. Putnam, Boston, Mass.; Mr. V. M. Spunar, Pittsburg, Pa. Nine applications for membership were received. The total membership of the society is now 623.

Committees were appointed to arrange for the summer meeting and to report on the matter of the publication of the Princeton Colloquium Lectures.

The Annual Register for 1910 has recently been issued, and copies can be obtained from the secretary. The catalogue of the library, which is published separately, includes over 3,000 volumes.

The following papers were read at the February meeting:

G. D. Birkhoff: "A simplified treatment of the regular singular point."

G. D. Birkhoff: "Some oscillation and comparison theorems."

P. F. Smith: "On osculating bands of surface-element loci."

Eduard Study: "Die natürlichen Gleichungen der analytischen Curven im euklidischen Raume."

G. A. Miller: "Addition to Sylow's theorem."

Peter Field: "On the circuits of a plane curve."

C. L. Bouton: "Examples of transcendental one-to-one transformations."

Jacob Westlund: "On the fundamental number of the algebraic number field $k(\sqrt{m})$."

L. P. Eisenhart: "Surfaces with isothermal representation of their lines of curvature and their transformations (second paper)."

Edward Kasner: "Isothermal nets."

Arthur Ranum: "On the principle of duality in spherical geometry."

O. E. Glenn: "On multiple factors of ternary and quaternary forms: applications to resolution of rational fractions."

The San Francisco Section of the society met at Stanford University on February 26. The Chicago Section meets at the University of Chicago on Friday and Saturday, April 8–9. The next regular meeting of the society will be held at Columbia University on Saturday, April 30.

F. N. COLE,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 466th regular meeting of the society was held on February 12, 1910, in the main lecture hall of George Washington University, with Vice-president E. W. Nelson in the chair and a large attendance of members.

Under the heading "Brief Notes," Dr. Barton W. Evermann told of recent experiments in feeding fur-seals in captivity made by Mr. Judson Thurber, boatswain of the Revenue Cutter *Bear*. Two starving seal pups were captured on the Pribilof Islands, October 9, 1909, and delivered to the *Bear* on October 14. They were fed on condensed milk and later on fish, and were successfully conveyed to Seattle, and thence to Washington, where they are now on exhibition at the Fisheries Building, both in excellent health. It is hoped that the practical outcome of this experiment will be the saving of a large number of the young seals on the Pribilofs that are usually lost because of the destruction of the mothers through pelagic sealing.

The following communications were presented:

On Alaskan and Far Northern Mosquitoes: L. O. HOWARD.

Dr. Howard spoke briefly on Alaskan and other far-northern mosquitoes, quoting from the published accounts of arctic explorers and from letters received from travelers in Alaska and other sub-polar and polar regions. It appears that in the short arctic summer mosquitoes are excessively numerous and bloodthirsty, although the number of species involved is apparently very small. Most of the species from such regions in the collection of the National Museum, on the authority of Mr. F. Knab, belong to the genus *Ædes*, a group which winter in the egg state and produce a single generation upon the melting of the snows. The development of the larvæ is rapid and almost simultaneous, resulting in a veritable explosion of adult mosquitoes.

A Collecting Trip to Alaska (illustrated by lantern slides): A. S. HITCHCOCK.

During the summer of 1909, Professor Hitchcock, systematic agrostologist, U. S. Department of Agriculture, made a trip through interior Alaska for the purpose of studying and collecting the grasses of this region, which is comparatively little known botanically. Starting from Seattle, June 15, he visited Juneau, Sitka and Cordova, from which latter point an excursion was made up the Copper River on the new railroad to Miles Glacier. Returning to Juneau, he went to Skagway and over the White Pass to White Horse, where he was joined by Mr. R. S. Kellogg, of the Forest Service. Besides short stops at intermediate points, he visited Dawson, Rampart, Hot Springs, Fairbanks, Fort Gibbon, St. Michael and Nome, returning to Seattle direct.

Alaska consists of several well-marked regions. The coast region lies between the coast and the extension of the Cascade range of mountains, which becomes the Alaska Range. This high range includes the high peaks, Mt. St. Elias and Mt. McKinley. The climate of this region, extending from Ketchikan in southeastern Alaska to Cook Inlet, is similar to that of the Puget Sound region. It is characterized by great rainfall (111 inches at Sitka; as much as 60 feet of snow in winter at Valdez), equable temperature (it is no colder in winter at Sitka than at Washington), and the prevalence of cloudy and foggy days. The Yukon Basin, which includes a large part of the interior, has, on the contrary, a continental cli-

mate. The winters are very cold, while the temperature in summer may be uncomfortably warm, not infrequently above 90° F. in the shade. The rainfall is small (10 to 14 inches) and the weather is normally clear and pleasant. The Yukon Basin is separated from the Arctic Slope by a low range of mountains, the continuation of the Great Continental Divide. The greater portion of Alaska is timbered, the southeastern portion quite densely so, the timbered area including all except the Alaska Peninsula and the Aleutian Islands, the deltas of the Yukon and Kuskokwim rivers, most of Seward Peninsula, and the Arctic Slope. The timber line is usually between 2,000 and 3,000 feet altitude. Except along the rivers, the forests of interior Alaska are sparse and scattered, the trees being rarely over one foot in diameter. In this region the prevailing species are white and black spruce (*Picea canadensis* and *P. mariana*), aspen (*Populus tremuloides*) and white birch (*Betula alaskana*).

The conditions at Hot Springs are of special interest. The hot water is used for a variety of purposes, including the heating of greenhouses and a large hotel. The soil conditions over an area of several acres are so modified that the flora is quite distinct. Many plants were observed here and in no other locality in Alaska, plants which are native much further south. The timber on this area is distinctly larger. Mr. Kellogg noted an aspen eighteen inches in diameter, and the large birch trees were conspicuous.

Especial attention was given to the grasses, of which 900 numbers were collected. The grasses of the coast region are well known, this region having been visited by several botanists. Few collectors have penetrated to the interior and our knowledge of the grass flora of this large and interesting region is very meager. The number of species of grasses is small, surprisingly so if we exclude the recent immigrants. Nevertheless, the grasses form a very important part of the flora. The dominant genus is *Calamagrostis*, of which there are several species. *Arctagrostis arundinacea* and species of *Calamagrostis*, especially *C. canadensis*, form the bulk of the grass flora, and may cover vast areas in the more or less open spruce forest.

In spite of the low rainfall and the comparatively dry summers, the soil is usually cold and moist in the valleys and often on the lower mountain slopes. This is due to the poor drainage. The soil is permanently frozen for several yards below the surface, a thin surface layer thawing out each summer.

The tundra region of Nome is distinctly different from the interior and from the southern coast. The lack of trees and the more severe climate modify the flora. The tundra itself, marshy land with ponds and lakes interspersed, contains few grasses, the grass-like plants being mostly sedges. The hills and sandy or gravelly knolls show, however, a greater variety of grasses than the interior valleys. The flora of Nome is scarcely arctic, though many arctic species are found here. The true arctic flora is found on the Arctic Slope and extends down along the coast to the north shore of Seward Peninsula.

D. E. Lantz,
Recording Secretary

THE CHEMICAL SOCIETY OF WASHINGTON

The 196th meeting was held in the lecture hall of the public library on February 10, 1910. President Failyer presided, the attendance being 79. The following committee was appointed to solicit subscriptions for the George Washington Memorial building: F. P. Dewey, W. F. Hillebrand, E. T. Allen, W. N. Berg, F. K. Cameron, V. K. Chesnut, E. A. Hill, C. S. Hudson, W. B. D. Penniman, C. A. Rouiller, A. Seidell. S. S. Voorhees.

F. P. Dewey read a paper on the "Solubility of Gold in Nitric Acid," in which he showed that contrary to the usually accepted opinion, gold, especially when finely divided, is easily soluble in boiling nitric acid of 1.42 sp. gr. Various yellow solutions containing 100 to 200 mg. of gold per liter were prepared, while one solution carried over 660 mg. of gold per liter.

C. L. Alsberg and O. F. Black presented a paper on the "Detection of the Deterioration of Corn with special Reference to Pellagra." Dr. Alsberg presented the paper and showed that the etiological connection between pellagra and spoiled corn was regarded by several European governments as so probable that stringent grain inspection laws have been passed. Inspection is effective only when done with chemical methods. These methods were discussed on the basis of analytical studies. The conclusion reached was that, while no single method is applicable in all cases, the acidity, determined according to a fixed procedure, is the best single criterion for estimating the degree of deterioration.

J. A. Le Clerc,
Secretary

SCIENCE

FRIDAY, APRIL 1, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE CULTURAL FACTOR IN THE DENTAL CURRICULUM[1]

FIRST of all let me discharge the pleasurable duty imposed upon me by the administration of the University of Pennsylvania and its faculty of dentistry, by conveying to you their fraternal greetings and hearty congratulations upon the completion of this splendid edifice which to-day you dedicate to the purposes of education in an important specialty of the science and art of healing.

It is characteristic of the things of the mind that they are unhampered by the limitations of time or extent, that the commonwealth of intellect is without geographical boundaries or distinctions of caste, race or nationality; that the pursuit of the intellectual ideal lifts all to the level of a common brotherhood; and it is in the spirit of this larger fraternalism that I bring you the salutations and greetings of one of the oldest institutions of learning established by England in her American colonies. It is by reason of our common origin as well as by reason of our common ideal that I have a peculiar pleasure in being present upon this happy occasion as the temporary mouthpiece of an elder sister institution to discuss with you briefly something of the circumstances and conditions which environ the special department of education with which we are mutually concerned, and, claiming the prerogative of an elder sister somewhat, to point out a few of the difficulties to be overcome by her younger

[1] Delivered at the dedication of the new building of the Royal College of Dental Surgeons, Toronto, December 29, 1909.

relative who, with the enthusiasm and pride begotten of a new and faultless dress, starts out to-day refreshed and eager upon her educational pathway.

While dentistry and possibly dental education, in some sort or degree, is doubtless coeval with man and man's physical needs, dentistry as an organized department of activity and education is but seventy years old, its inception as a profession dating from the establishment of the first school for the systematic education of dental practitioners in Baltimore in 1839. From this initial and successful attempt at organization upon an educational basis have arisen all subsequent efforts having the same objective purpose, notwithstanding the individual differences as to means and methods which they severally involve.

From the first successful attempt to provide the means for the systematic education of the dentist down to the present time both the effort and its practical realization have been "hedged round and about" by opposing opinions as to the relationship which dental education should rightfully bear to medical education. And while the arguments of those who would compel the merging of dental education within the medical curriculum are even now manifesting another periodical recrudescence, the process of evolution and the incontestable logic of fact and experience are more and more firmly establishing dental education upon an autonomous basis.

It is not my purpose to enter into a discussion of the relationships of dentistry and medicine further than to call attention to the fact that from its beginnings as an educational system dental education has been subject to more or less stress of criticism because it has elected to develop outside of the channels of medical education and to mark its qualification with a degree distinctive of its own special culture.

That our professional forebears were wise in their decision to place dental education upon an independently organized basis is a conclusion which I think is justified by the practical success of their plan, which in its evolution and development has given to the world the profession of dentistry as we now find it ministering acceptably to the health and comfort of humanity in all civilized nations.

The social conditions, the social needs of humanity to-day, are, however, not the same as those which characterized the period when dentistry as a profession was in its swaddling-clothes. To quote a recent phrase of President Eliot, "the world has been remade in the last half century," and it will, I think, be profitable for us to consider to what degree dentistry and dental education have kept pace with this world development; in other words, has dentistry remade itself in keeping with the intellectual and material progress of society?

Mr. Herbert Spencer enunciated as his broadest and most comprehensive definition of life that it is "the continuous adjustment of internal relations to external relations." Applying this definition to the case in hand, our inquiry concerns the degree and extent of the adjustment which dental education has maintained with respect to its environing social relations; has it in its educational methods reflected the intellectual progress of the times and fairly met the demands of the social order by a continuous adjustment thereto, thus demonstrating its right to live?

From the material point of view no other than an affirmative answer is possible. When we consider the aggregate of pain and suffering that has been mitigated or completely banished by the skillful ministrations of the dental practitioner, when we think of the added years of comfortable human life, the relief of distress from dis-

figurement, the restoration of comeliness, the prevention of disease, the correction of deformities and of defective speech and, above all, the boon of surgical anesthesia given to humanity by dentistry, surely no one can doubt its importance and utility as a department of the great science and art of healing.

In its technical procedures and its artistic craftsmanship dentistry has acquitted itself so creditably that the flexibility of its technical resourcefulness has become proverbial, yet to such an extent has the attention of the dental profession been focused upon the material side of its progress that we have failed, I fear, in no small degree, to grasp its larger possibilities and to appreciate the importance of those factors of professional life upon which a higher attainment, a greater usefulness to humanity and a wholesome self-respect depend.

As a counter influence to this concentration of attention upon the material features of dental practise with its commercializing tendencies there is needed above all things an aggressive propaganda of education the objective purpose of which shall be the development of that type of culture which is expressed as professional character. In making this statement I fully realize that I am simply rephrasing a belief which has been frequently expressed before, but because of that very fact it is all the more evident that it represents a condition broadly recognized both within and without the limits of the dental profession.

A tendency to indifference toward those things which make for professional character has subjected us of the dental profession to not infrequent criticism, and some who recognize the condition without investigation of the cause are inclined to place the responsibility directly upon our dental educational institutions. That our dental colleges should become the target for criticism of that character is not unnatural, nor do I think that it is altogether unmerited.

As the seed ground for the development of professional skill and qualification through training and technical education, so also the colleges of dentistry should be the nurseries of professional character and culture. I take it for granted that there can be no dissension as to the general truth of that question, nor do I think that there can be any real doubt as to the fact that while we have given much attention to his technical education at all points, there has not been given proportionate attention to the cultural features of our educational system in the preparation of the student for his professional life.

It is in his college course and because of his college course that the student acquires and later manifests as a practitioner that tendency to concentrate his attention upon the material features of his work which I have before referred to as a professional attribute which gives rise to adverse criticism and creates the demand for a broader training for the dentist, less narrowing and commercializing in its tendency.

The general answer of our dental educational institutions to this kind of criticism is that they are purely technical schools, that they are compelled to deal with the material delivered to them by the preparatory schools, that defects in intellectual culture are chargeable to faulty preparation, that the business of the dental college is to teach dentistry, not to develop culture. This defensive attitude is only partially true, for while we may concede that the preliminary education of the dental student should have done much to broaden his mind and to have aroused to activity in him those intellectual attributes which later become fixed

in character, it must be remembered that the process has only been begun in the preparatory school and that three or four years of purely technical professional study may quite easily neutralize the cultural effect of his preparatory work unless his professional training is conducted with reference to conserving and further developing his powers of intellectual growth.

I realize full well that I am likely to arouse an attitude of incredulity, even possibly of scorn, by the suggestion that anything in the curriculum of dental study may have a cultural value as such, quite apart from its material technical usefulness; but because I believe that something more than mere technical training can be gotten out of the dental course, that something in the nature of character development may be derived from doing the work of the dental curriculum, I am encouraged to present that side of the question, for I am convinced that its due recognition will eventuate not only in relieving those of us who are teachers of a source of criticism, but also it will greatly improve the grade and texture of our educational product and make our graduates not only better dentists but men of larger intellectual resources and therefore more acceptable members of society.

Can the dental curriculum be utilized for the attainment of these desirable ends? Let us seek the answer in an analogy. It may be stated almost axiomatically that in the materialization of great artistic conceptions the character of the medium in which they may be expressed is a minor consideration. What concerns us most in the contemplation of a statue, for example, is not the material of which it is made, but is it good art, does it bear the stamp of artistic genius? The creations of the greatest masters of harmony were in many cases interpreted upon instruments of inferior grade, but the soul of music may speak its divine message through any medium, and enthralled by its spell, we care not if it be "blown through brass or breathed through silver." So also in the utilization of education for the ends of culture it is not the means by which the intellectual activities are set in motion that are of primary importance, but rather the ends toward which our educational efforts are directed, and it is these that should mainly concern us both as teachers and as students.

Education dominated by the purely utilitarian *motif,* as most of our modern education is, loses its cultural effect by concentrating the mental faculties upon the function of acquisition, of getting, as an intellectual process. The graduate thus trained goes forth to his life work, which consists for the most part in converting his mental potential into terms of material possession.

By the overemphasis of the utilitarian ideal those faculties of the mind, the exercise of which creates a taste for the higher orders of intellectual enjoyment, suffer from arrest of development, under which conditions any process of thought that does not work out to a concrete material end becomes impossible.

In this way we are not only creating a deformed and one-sided educational product, but still worse, we are closing the doors that lead to the sources of highest human happiness. The age is essentially utilitarian, the demand is for the practical and for the kind of education which may be ultimately expressed in terms of material prosperity. In response to the universal clamor for an education that will help to achieve these material ends, our schools, our seats of higher learning, are yielding, many of them under protest, to the general demand. The old and one-time popular type of education, the study of Greek and

Latin classics, is becoming obsolete and the demand is that modern language training shall replace the study of Greek and Latin because of the greater usefulness of modern languages in the practical business of life. Regarded simply as mental discipline the exchange of modern language study for the ancient tongues may have entailed no serious loss, and possibly, from the standpoint of material usefulness, the exchange may have even been attended with a certain degree of gain, but what has been lost is the uplifting effect of the Greek ideal, the spiritualizing power with which the activities of life became invested by contact with Greek thought and culture.

In his portrayal of the processes of intellectual growth of his young hero, Walter Pater says of Marius the Epicurean:

> He was acquiring what is the chief function of all higher education to impart, namely, of so relieving the ideal or poetic traits, the elements of distinction in our everyday life—of so exclusively living in them—that the unadorned remainder of it, the mere drift and débris of our days, comes to be as though it were not. . . . If our modern education in its better efforts really conveys to any of us that kind of idealizing power it does so (though dealing mainly, as its professed instruments, with the most select and ideal remains of ancient literature) oftenest by truant reading.

We have here, I think, the admission by one who was himself one of the illuminati of classic learning that while the "most select and ideal remains of ancient literature" are the professed instruments by which the idealizing power is directly awakened in the human intellect, yet the divine spark of inspiration is oftenest caught from "truant reading." But why necessarily or exclusively from reading of any sort in the literal sense? Is there not in the world about us, in the study of the material universe of which we are a part, the contact with which involves not only our struggle for existence but our effort to solve the riddle of life, the stuff from which all books, all literatures are derived? Is it not from these sources that the poets, the sages, the inspired ones of all times have heard the divine message and transmitted it in immortal terms to humanity?

Those leaders of education who have yielded a willing ear to the general demand for utilitarianism as the dominating principle in our educational system, have justified their position by a narrow interpretation of Herbert Spencer's epoch-making question of "What knowledge is of most worth?"

The deduction that only the knowledge which has any worth at all is that kind which may be converted to material use is an injustice to the intellectual breadth of the great philosopher which is not warranted by his own statement of his case. In his contention as to the superiority of scientific study over other means of education he says:

> The discipline of science is superior to that of ordinary education because of the religious culture that it gives. So far from science being irreligious, as many think, it is the neglect of science that is irreligious. Science is religious inasmuch as it generates a profound respect for and an implicit faith in those uniform laws which underlie all things. By accumulated experiences a man of science acquires a thorough belief in the unchanging relations of phenomena, in the invariable connection of cause and consequence, in the necessity of good or evil results. He sees that the laws to which we must submit are not only inexorable but beneficent. He sees that in virtue of these laws, the process of things is ever toward a greater perfection and a higher happiness. Science alone can give us true conceptions of ourselves and our relation to the mysteries of existence. Only the sincere man of science—and by this title we do not mean the mere calculator of distances, or analyzer of compounds, or labeler of species; but him who through lower truths seeks higher and eventually the highest—only the genuine man of science, we say, can truly know how utterly beyond not only human knowledge but human

conception is the universal power of which nature, and life and thought are manifestations. For discipline as well as for guidance, science is of chiefest value. In all its effects, learning the meaning of things is better than learning the meanings of words. Whether for intellectual, moral, or religious training, the study of surrounding phenomena is immensely superior to the study of grammars and lexicons.

In the passages which I have just quoted it seems to me we may find the vitalizing thought which honestly and intelligently applied to our educational work should ultimately lift it out of the slough of unrelieved materialism in which it is at present struggling, and help us to reform it upon lines which shall restore to all education the power to direct the mind toward the contemplation of higher things and thus to elevate the standards of reasonable human living and of human happiness.

Herbert Spencer, an accepted exponent of scientific thought, tells us that we must seek the higher truths through the lower orders of phenomena, which is simply the unadorned statement of an evolutional law, but a law which is the basis of all development of the mind, of all intellectual progress. Ages before anything worthy the name of science was conceived of, the mind of man in its earliest gropings took its first wavering steps toward the infinite through the labyrinth of common things about him, and out of his material experiences he began to weave the fabric of an intellectual vestment which was later destined to clothe his conception of his gods and his holy ones, and thus make it possible for him to worship the infinitely good, the true and the beautiful. And so it has been in all ages, for while we recognize the fact that each age refines and improves upon the experiences of its predecessors, yet the individual in his mental and cultural growth repeats the old journey, more easily perhaps, but nevertheless he must gain his goal by experiences concerned with the lower orders of truth before he can reach the higher. The poets, philosophers and artists of all times have reflected the same thought. If I catch his meaning aright it is a portrayal of this fundamental principle which we find set forth by Robert Browning, in that confession of his faith entitled "Christmas Eve and Easter Day," where he breaks forth in that magnificent declaration of the apotheosis of the love element in life—

Love which, on earth, amid all the shows of it,
Has ever been the sole good of life in it,
The love ever growing there spite of the strife in it,
Shall arise, made perfect, from Death's repose of it;
And I shall behold thee face to face,
O God, and in thy light retrace
How in all I loved there, still wast Thou.

It was the reaching out for these higher conceptions that characterized the best culture of the ancient Greeks, and conversely it is our tendency to subordinate these higher attributes of the mind in relative importance as compared with materialism and utilitarianism that is the defective feature of our modern systems of education. In our efforts to adapt education to the ends of material progress we have lost sight of the possibility, nay more, we have neglected the duty, of seeking for the higher orders of truth through the lower orders of phenomena with which we deal in our educational work. We have concentrated our attention too much upon the media of education and have in so doing neglected the most important ends of education, the cultivation of those higher attributes of character that satisfy the demand for happiness, that make life a joy well worth the living.

If such character development as produced the best culture of the Greeks were possible under the conditions of human knowledge and material development then

existing, how much simpler and more direct should be the access to a similar cultural development under the conditions of our modern civilization.

Our failure to discover the cultural value of the educational material with which we are now dealing has resulted from our intense preoccupation with the lower orders of phenomena and our consuming desire to utilize them for the ends of material prosperity.

We must reestablish the ancient ideal, which the best culture of all peoples has shown to be the development of an appreciation for the higher orders of truth, a love for the study of causes behind phenomena, and an abiding faith in the fact that the larger happiness of life is to be found in the things of the mind rather than in material acquisitions.

It is this ideal which must govern us as teachers if we are to hope to in any degree stem the tide of materialism and commercialism with which our work is at present dominated. We must realize that the work of the classroom and the laboratory is susceptible to the vitalizing influence of the cultural principle. To bring out from the study of the lower orders of phenomena with which he deals, an appreciation of the underlying forces, the *Weltgeist* of which the material things of life are but the outer cloak, is the mark of the true teacher as distinguished from the novice, just as it is the same order of intellectual development in the laboratory, the studio or the shop that marks the difference between the master and the apprentice, the artist and the artisan respectively.

I believe that the principle which I have thus attempted to portray is directly applicable to the work of the dental curriculum, as it is to all education. Dentistry in its scientific aspect may be regarded as a special department of the great science of biology combined with certain phases of chemistry and physics. Its art is merely the application of these sciences to the ends of practise, but in their practical application the cultural elements of honesty of purpose, faithfulness to artistic ideals, a love of the intrinsic beauty of nature's designs and a veneration for nature's laws are essentials for success. These higher cultural attributes it should be the part of the teacher to develop from the study of the data which comprise the lower order of phenomena of the dental curriculum.

To all who sympathetically and intelligently give ear to the voice of nature the pathway is clear, for, as Robert Louis Stevenson has beautifully expressed it:

> The Greeks figured Pan, the god of nature, now terribly stamping his foot, so that armies were dispersed; now by the woodside on a summer noon trolling on his pipe until he charmed the hearts of upland ploughmen. And the Greeks in so figuring uttered the last word of human experience. To certain smoke-dried spirits, matter and motion and elastic ethers and the hypothesis of this or that spectacled professor tell a speaking story; but for youth, and all ductile and congenial minds, Pan is not dead, but of all the classic hierarchy alone survives in triumph; goat-footed, with a gleeful and an angry look, the type of this shaggy world; and in every wood, if you go with a spirit properly prepared, you will hear the note of his pipe.

Our mission then as teachers of a humane and useful profession is to penetrate this "shaggy coat" of materialism, this commonplace and unattractive covering of the divine spirit behind it all, and to so educate those committed to our charge that they shall, in God's providence, be able to see something more than "the seamy side of the divine vestment which the earth-spirit is forever weaving on the whirling loom of time."

EDWARD C. KIRK

THE PROBLEM OF THE ASSISTANT PROFESSOR. III

PART II

The foregoing part represents the problem as seen from one point of view. It is therefore partial, incomplete. For the sake of completeness, a questionnaire (Appendix B) was prepared and sent to the presidents of the twenty-two institutions. The queries were drawn up for the purpose of showing, if possible, some of the broader movements which have affected and are affecting the status of the assistant professor, and also to get light from the administrative standpoint on the lower and upper limits of requirements for the position, etc.

An unfortunate clerical error, discovered too late for correction, called for data concerning students and staff for the years 1890–1 and 1900–1, instead of 1899–1900 and 1909–10. This was kindly remedied in some of the replies; while it was possible from other data available partially to remedy the error in a few other cases. It is greatly to be regretted that but ten practically complete replies had been received when the time for compilation arrived. It is obvious, for instance, that the present actual average salary of the assistant professor in these institutions could have been obtained (and used as a check on the result in Part I., as to whether the replies came from typical representatives of the rank), if answers had been received from each institution as to the number of assistant professors and the average salary. Because of partial answers, the showing of growth of student body and staff must also be omitted. The general trends of these are too well known to need demonstration here. The following table (VII.) has been compiled, however, from the data at hand, to show the change in the proportionate composition of staff which has taken place in the past twenty years.[9]

It is seen that while the assistant professors have formed a practically constant or slightly increasing proportion of the entire staff, the proportion of the staff above

TABLE VII

Proportionate Composition of Staff

	Assistant Professors in Staff						Staff above Assistant Professor						Staff below Assistant Professor						
	Yr.	%	Yr.	%	Yr.	%	Yr.	%	Yr.	%	Yr.	%	Yr.	%	Yr.	%	Yr.	%	
California	'87	5.6			'07	26.4	'87	44.5			'07	26.8	'87	50			'07	46.8	Assoc. and full above.
Chicago			'00	14.7	'08	14.1			'00	36.9	'08	39.9			'00	49.4	'08	46	Assoc. and full above. Also professorial lecturers.
Columbia	'89	6.1	'00	4.3	'09	10.7	'89	16.7	'00	20.5	'09	27.7	'89	77.2	'00	75.2	'09	61.6	Adjunct profs. Probably more legitimate to take "associates."
Cornell	'89	16.5			'09	17.1	'89	35			'09	18.2	'89	48.5			'09	64.7	
Harvard	'89	15.2	'00	12.2	'04	13.7	'89	37.3	'00	23.2	'04	23.8	'89	47.5	'00	64.6	'04	62.5	A few associates.
Indiana	'89	0	'00	23.8			'89	85.2	'00	40.2			'89	14.8	'00	36			Assoc. and full above.
Iowa	'89	7	'00	9			'89	69.6	'00	53.9			'89	23.4	'00	37.1			
Johns Hopkins	'89	20.8	'00	20.7	'08	18.5	'89	56.4	'00	45	'08	46	'89	22.8	'00	34.3	'08	35.5	Called "associates." Assoc. and full above.
Kansas			'00	28.4	'09	25.2			'00	56.7	'09	42.5			'00	14.9	'09	32.3	Assoc. and full above.
Leland Stanford Jr.	'91	15.6			'09	18.2	'91	46.9			'09	35.3	'91	37.5			'09	46.5	" " " "
Minnesota	'89	11.1	'00	8.7			'89	66.7	'00	30.4			'89	22.2	'00	60.9			" " " "
Missouri	'89	22.6	'00	15			'89	67.7	'00	66.7			'89	9.7	'00	18.3			" " " "
Wisconsin	'89	11.5	'00	22	'07	15	'89	73.1	'00	34.6	'07	26.4	'89	15.4	'00	43.4	'07	58.6	" " " "
Yale	'89	6.3	'00	7.7	'09	18.4	'89	46.5	'00	36.5	'09	27.4	'89	47.2	'00	56.7	'09	54.2	

[9] See also SCIENCE, May 14, 1909, pp. 767–770.

this rank has diminished to about one half what it was twenty years ago, and the proportion of the lower ranks has correspondingly increased. The assistant professor of to-day, in other words, must win his way *out* of a larger group and *into* a much smaller group, relatively, than did the assistant professor of twenty years ago. This means that the competition is severer both for the position and for promotion out of it.

The replies to query 2*c* were unanimous that the present requirements for the position are more exacting than they were twenty years ago. These facts explain the high age of the men (36.8 average) shown in Part I.

When we compare our incomplete results with those shown in Bulletin No. 2 of the Carnegie Foundation (pp. 29–32), we find our average reported salary of $1,790 for twenty of the strongest institutions as compared to an average of $1,600 for about one hundred institutions. It is there found that the age of entrance to a grade allotted an average salary of $1,500–$2,000 is thirty years. We find from our replies 31.25. This checks remarkably well, the difference being such as we should expect to find, owing to the difference represented by the smaller and the larger group of institutions.

The returns for the age of entrance into full professorship, there stated to be 34 years, based on those *now holding* the rank, would show a considerable change, I feel sure, if we had the average of those *now being appointed* to that rank. This is obvious, since a large proportion of those making up the entrance age of 34 were appointed under the conditions prevailing 15 to 20 years ago. The conclusions drawn on page 32 of the bulletin: "A man acceptable to these institutions for a position worth $1,250 will be on the average 25 years old; a man appointed to a position worth $1,750 will be on an average 31 years old when appointed to it; one appointed to a position worth $2,500 or over will be on the average 34 years old" necessarily refer to what has been rather than to what is.

It would probably be nearer present-day facts in the average of these institutions to state that from 27 to 31 a man receives an average salary of $1,100; from 31 to 41 an average of $1,800, and from 41 on $2,500 or more. It would be interesting to get the actual facts in any institution as to this trend in change of age of promotion, by taking the average age of those promoted to full professorship in each year for the past twenty-five years; thus showing the tendency as affecting the most highly successful members of the profession.

Table VIII. has been compiled partly from the replies, partly from data already in the hands of the writer, and partly from Bulletin No. 2 of the Carnegie Foundation. Owing to its incomplete nature, we are not justified in drawing from it the general conclusions which it was hoped to obtain. It is, however, introduced on account of its value for purposes of comparison.

The replies to the queries in general are grouped alphabetically by institutions, and are, by permission, credited to their authors.

Queries 2*a*, *b* asked:

(*a*) Whether any basis of requirements for eligibility to promotion from instructorship to assistant professorship had been formulated, and (*b*) what would be considered suitable qualifications.

The replies:

(*a*) No. (*b*) It would be difficult to be precise. An instructor's term is three years. One or two such terms should indicate whether one is qualified for promotion.—President Judson.

TABLE VIII

Salary of Assistant Professor

(compiled from various sources)

	Year	Minimum	Maximum	Average	Year	Minimum	Maximum	Average
California	'89			1,800	'07			1,620
Chicago					'09	2,000	2,500	2,102
Clark					'07			1,650
Columbia[10]					'07			2,201
Cornell	'88			1,760	'07			1,715
Harvard	'89	2,000	2,500		'07 '09	 2,500	 3,000	2,719
Illinois					'07			1,851
Indiana					'09	1,000	1,300	1,083.33
Iowa	'89	1,200	1,800	1,400	'09	1,100	1,800	1,418
Johns Hopkins					'07			1,344
Kansas	'89			1,050[11]	'09	1,000	1,500	1,250
Leland Stanford Jr.	'91	2,000	2,500	2,250	'08	1,500	2,500	1,827
Michigan					'07			1,624
Minnesota	'89	800	1,350	1,162.5	'09	1,400	2,400	1,791
Missouri					'09	1,500	2,000	1,800
Nebraska					'07			1,500
Pennsylvania					'07			1,850
Princeton					'07			1,824
Virginia					'07			1,425
Wisconsin	'89	1,100	1,500	1,250	'09	1,500	2,500	1,733
Yale	'88	1,750	2,500	1,900	'09	1,800	2,500	2,100[12]

(*a*) No fixed requirements. (*b*) I should be unable to put them into the shape of any fixed formula.—President Lowell.

(*a*) The doctor's degree or the equivalent. (*b*) If, as is usually the custom, the assistant professor is to teach freshmen, he should be a man whose character, disposition and training make him fit for this important work. Many young doctors are notably unfit.—President Bryan.

(*a*) The university has not definitely formulated a basis of requirements for eligibility for promotion from instructors to assistant professors. (*b*) Assistant professors should be from 30 to 35 years of age; have had training equivalent to that required for the degree of doctor of philosophy; should have demonstrated their ability as teachers to impart knowledge and inspire interest in their subject; should have had a minimum of perhaps five years of teaching experience.—President MacLean.

(*a*) Nothing very definite. (*b*) Ordinarily the instructorship should serve as an apprenticeship for the candidate for a position in the required teaching force of the institution. The instructor should have such training and qualifications as to fit him for the minor work in his department, and to cause him to be seriously regarded as a prospective candidate for permanent position.—Dean Templin.

(*a*) A man who fills well a position permanently needed. (*b*) (1) Character. (2) Teaching ability with enthusiasm. (3) Scholarship. (4) Fitness for advancement as an original scholar. I should place age and experience lowest.—President Jordan.

(*a*) No. (*b*) Age 23 to 30. Scholarship, A.B. and Ph.D. degrees with what they are supposed to indicate. Teaching ability, clear view of things and power to impress and inspire. Experience, as much as possible at the age.—President Northrop.

(*a*) The general understanding is that for promotion to rank of assistant professor, a man must give definite evidence of productive scholarship as well as teaching ability. (*b*) Can not formulate answer.—President Hill.

(*a*) No. (*b*) Do not feel able to formulate answer to this question offhand.—President Van Hise.

(*a*), (*b*) We promote a man from an instructorship to an assistant professorship if, after three years of teaching, he has shown exceptional fitness for teaching and research; or if, after five years of teaching, he has shown such reasonable degree of success in instruction and administration as entitles him to promotion.—President Hadley.

Query 2*c* asked if these requirements are more exacting than they were twenty

years ago. The replies were unanimous that they are so.

Query 3*a*, *b*, asked the minimum, maximum and average salaries paid in this rank now, and twenty years ago. The replies are included in Table VIII.

The question to be raised here is, ignoring all change in cost of living, whether there has been a change in salary commensurate with the higher requirements for the position. Of the nine institutions whose data are available, three (California, Cornell, Stanford) show an actual decrease in the average rate of salary for the assistant professorship; one (Iowa) shows practically no change; one (Yale) an increase of 10 per cent.; one (Kansas) an increase of 20 per cent.; one (Harvard) about 25 per cent.; one (Wisconsin) about 40 per cent.; and one (Minnesota) 55 per cent.

The increase at Wisconsin has been uniform over the period, as can be seen from the following table:

Year	1889	1892	1901	1907	1909
Salary	$1,250	$1,383	$1,500	$1,636	$1,733

At Harvard the increase came suddenly about three years ago, due to the Teachers' Endowment Fund; and at Minnesota suddenly about two years ago, largely due to the pressure brought to bear by the alumni upon the legislature and regents, in consequence of which a considerable general increase was made in the salary roll.

In looking at Table VIII., it should be borne in mind that some of these institutions have the associate professorship, intermediate between assistant and full professorship, while some do not.

[10] New regulations 1909. $1,600 at appointment, 100 annual increment four years.

[11] An increase of 20 per cent., approximately, in twenty years.

[12] Two or three exceptional cases make an apparent range from $1,500 to $3,000.

Query 3*c* asked, from the point of view of the value of their services to the institution, what would be considered a proper ratio between the average salaries of assistant and full professors.

The replies:

With us the assistant professor's salary is from $2,000 to $2,500, and the full professor's from $3,000 to $4,500. That indicates our view.—President Judson.

A little less than double.—President Lowell.

Assistant professors should have a higher salary. Full professors should have salaries sufficient to induce the best men to follow this occupation.—President Bryan.

From the point of view of the value of their services to the institution as well as from the point of view of the demands upon them, the assistant professor's salary should be roughly two thirds or three fourths that of the full professor.—President MacLean.

One to two.—Dean Templin.

Average about half. But "full" professors do not always "grade up."—President Jordan.

Impossible to establish a fixed rate. If professors get $3,500, assistant professors ought, after trial, to get $2,500.—President Northrop.

At present the salaries of [assistant professors range from $1,500 to $2,000, average $1,800 and of] full professors here range from $2,200 to $3,000. This seems as fair to the former as to the latter class.—President Hill.

Question disregards fact that at Wisconsin we have associate professors.—President Van Hise.

It must depend wholly upon the character of the institution.—President Hadley.

Queries 4*a*, *b*, *c* were drawn up to elicit information regarding: (*a*) Recognition of the existence of a class of permanent assistant professors, (*b*) if it existed, whether the present salaries were adequate for efficient life service, and (*c*) calling for suggestions in regard to meeting the problem of a permanent class of assistant professors.

The replies:

(*a*) Not formally. Practically an assistant professor who may not expect promotion would not be continued in the faculty. (*b*) It is not considered by us expedient to have such a perma-

nent class. (*c*) I should not have such a class at all.—President Judson.

(*a*), (*b*) We do not. After a certain length of service an assistant professor has hitherto been expected to win promotion or drop out. (*c*) This is a difficult problem as yet unsolved.—President Lowell.

(*a*) Yes. (*b*) No. (*c*) Instead of making a permanent class of assistant professors I would make a special class of professors who devote themselves to the training of college boys—a task as important as that of those who devote themselves to research.—President Bryan.

(*a*) We do not at present. (*b*) If conditions tend to form a permanent class of assistant professors the present salaries will not be adequate for efficient life-service in this work. (*c*) I would give them votes in the faculty and after the first five years of satisfactory service, life tenure and make their salaries proportionate to full professors' salaries rather than to instructors' salaries.—President MacLean.

(*a*) Yes. (*b*) No.—Dean Templin.

(*a*) Those most indispensable as men or as teachers or in research may look forward. (*b*) No. Salaries should be higher and discriminations keener. (*c*) I wish I could give any. It is one of the administrative problems most difficult to handle.—President Jordan.

(*a*) No. They are permanent if good enough. If vacancy occurs above them they may or may not be promoted. It depends upon whether a better man can be obtained. (*b*) No. There should be a general lifting of the salaries of the whole grade. (*c*) None.—President Northrop.

(*a*) No. All assistant professors are on permanent appointment and may look forward to promotion. (*b*) I think not, but with chance for promotion before all, the salary seems reasonable for assistant professors in comparison [about two thirds of full professors' salary]. (*c*) I should prefer not to make a man "assistant professor" till he demonstrates his fitness and capacity to become "professor" when maturer. I would also treat all teachers of professorial rank as equal in freedom, initiative, etc., before the administration.—President Hill.

(*a*) Assistant professors for definite period of appointment, commonly three years; associate professors, indefinite. (*b*) Salaries for assistant professors are too small, but not more so than for other classes of staff. [Ratio to full professors' salary (1907), associates 73.5 per cent., assistants 59 per cent., instructors 38.5 per cent.] (*c*) Would keep rank of assistant professor for definite period, and make that of associate professor permanent appointment.—President Van Hise.

(*a*) We desire not to form a permanent class of assistant professors if we can help it. If a man is not ready to rise above $2,500 with us, we make it easy for him to go to some other institution where research qualifications are less necessary for a full professorship. It occasionally happens that a man makes himself more useful to us as assistant professor than he could anywhere else and obtains a quasi-permanent position of this kind. (*b*) No. (*c*) I think it can be practically done away with if we recognize that nearly all men who make good assistant professors will make better independent teachers in schools where original deep thought is not so much required as it ought to be in university teaching.—President Hadley.

At Columbia it is recognized that there are certain men who might well remain assistant professors so long as they were in service, no matter what their compensation or the length of their experience. Persons whom it might prove to be desirable to retain in the service of the university, either as instructors or assistant professors, might, after having served for five years, be appointed by the trustees to serve during their pleasure, and their salaries fixed regardless of their grade. By making this provision for academic officers of this type, who are rather numerous, much of the pressure which is now felt to advance men to adjunct professorships and professorships, in order to reward them for long service or to give them increased compensation, would be relieved.

Queries 4*d*, *f*, *g*, *h*, *i* and *j* had bearing on the relation of length of service to salary and promotion. 4*d* asked whether salaries were graded with respect to length of service.

The replies:

Yes. $2,000 for first four-year appointment. $2,500 on reappointment.—President Judson.

Yes. $2,500 for first five-year appointment. $3,000 on reappointment.—President Lowell.

Yes.—President Bryan.

Length of service is one element to be taken into consideration.—President MacLean.

Yes.—Dean Templin.

Theoretically not so much as in fact.—President Jordan.

Yes.—President Northrop.

Yes, but not entirely, and we reckon the service elsewhere as well as here.—President Hill.

Yes.—President Van Hise.

First three years, $1,800; next five years, $2,500. A continued appointment after eight years' service is a rare exception.—President Hadley.

4*f* inquired whether length of service should constitute any claim to promotion.

The replies:

Not by itself.—President Judson.

Yes, if the other qualifications exist.—President Lowell.

No.—President Bryan.

One claim for promotion, but only one and must be considered with several other factors.—President MacLean.

Not alone, but should be considered.—Dean Templin.

Not much.—President Jordan.

Yes, other things being equal.—President Northrop.

Not apart from essential qualifications.—President Hill.

Yes.—President Van Hise.

Not after reaching the age where maximum service can be rendered.—President Hadley.

4*g* asked the length of service of the senior assistant professor in the institution.

The replies:

Fourteen years.—President Judson.

Not over ten years.—President Lowell.

Eight years.—President Bryan.

Eight years.—President MacLean.

Ten years.—Dean Templin.

Eight years.—President Jordan.

Eighteen years.—President Northrop.

Eight years.—President Hill.

Sixteen years.—President Van Hise.

Eight years. One with nominal rank, seventeen years.—President Hadley.

4*h* inquired the percentage of assistant professors promoted each year, on the average.

The replies:

20 or 21 per cent.—President Judson.

Cornell promoted nineteen assistant professors last year.—President Schurman.

Assistant professors are promoted at the expiration of the second five-year term—with very rare exceptions.—President Lowell.

Perhaps one or two [men?].—President Bryan.

One, two or three promotions out of eight to sixteen or seventeen.—President MacLean.

10 per cent.—Dean Templin.

9 per cent., average past six years.—President Jordan.

Can't tell. It depends on needs and money.—President Northrop.

Unable to answer, as I have been president only one year.—President Hill.

12 per cent., average for past seven years.—President Van Hise.

Perhaps from 5 to 10 per cent.—President Hadley.

4*i*, *j* asked (*i*) whether promotions are as rapid or as general as the highest efficiency of the institution demands, and (*j*) if not, what are the chief causes of delay.

The replies:

(*i*) On the whole, yes. Rapid promotion is seldom desirable. (*j*) We have sometimes been delayed by lack of funds.—President Judson.

(*i*) Yes, I think so.—President Lowell.

(*i*) No. (*j*) Lack of money.—President Bryan.

(*i*) No. (*j*) Financial reasons.—President MacLean.

(*i*) Yes.—Dean Templin.

(*i*) Yes, but salaries are too low.—President Jordan.

(*i*) Yes, in most cases. (*j*) Lack of money.—President Northrop.

(*i*) Yes, I think so, as there are no barriers to the promotion of men who win the right. (*j*) Financial causes are most likely to operate against promotions here, but I do not believe that difficulty is as serious as appears in some institutions. In most deserving cases adjustments can be made. —President Hill.

(*i*), (*j*) Yes, so far as rank is concerned, but not as rapidly as desirable in the matter of money. —President Van Hise.

(*i*), (*j*) If I understand the question, I think so. Of course, if we had more money we should make more promotions instead of allowing some of our good men to go away; but I do not think increased rapidity of promotion as important a question as increased salaries for full professors. —President Hadley.

Query 4*e* asked the essential qualifications for eligibility for promotion from assistant professorship to the rank above. In considering the replies it is to be borne in mind that some of these institutions have an associate professorship and some have not.

The replies:

Assured capacity as a scholar and teacher, and as a productive investigator. Of course, personal character is fundamental.—President Judson.

I could not formulate this with definite precision.—President Lowell.

An adequate measure of excellence of some sort, primarily in scholarship, but excellence in the training of college youths is also recognized as a valid ground for promotion.—President Bryan.

Scholarship, proved by the results of a reasonable amount of research work together with some publications; teaching ability, proved by perhaps ten years of successful teaching; the test of success being applied a little more rigidly when promotion to a professorship is made, than before promotion to an assistant professorship.—President MacLean.

To be promoted, the assistant professor must have established himself as a permanently desirable member of the university faculty. His scholarship must be beyond question, as must also be his ability either as a teacher or an investigator.—Dean Templin.

(1) Character. (2) Ability as teacher. (3) Ability to form independent judgments. (4) Enthusiasm in work.—President Jordan.

Thorough knowledge of the subject, and executive ability to manage the department, and enthusiasm for the work that will inspire assistants and pupils.—President Northrop.

Greater maturity and more complete demonstration of ability in research, teaching, and general usefulness to the university.—President Hill.

Before promoting from assistant to associate professor, must become convinced that instructional power and investigational capacity sufficiently high, so that institution desires services of man for life.—President Van Hise.

The three qualifications for full professorship, in the order of average importance are, original scholarship, organizing ability and teaching power. Teaching power is placed third, not because of any under-estimate of its importance, but because men who are good teachers at thirty, but have not original scholarship or organizing ability, are apt to be (I do not say are always) less good teachers at fifty.—President Hadley.

To determine the academic and administrative status of the assistant professors, questions 5*a*, *b*, *c* and *d* were drawn up. They inquired (*a*) the participation of this rank in the legislating bodies, faculty, council, senate, etc.; (*b*) the voice in departmental matters; (*c*) whether on the same footing as full professors in respect to appointment to administrative and academic committees, which formulate, control or direct educational policies; and (*d*) in respect to appointment as executive heads of departments.

The replies:

(*a*) The senate consists of full professors. Council, of administrative officers only. Assistant professors are members of all faculties. (*b*) Yes. (*c*) Yes. (*d*) No.—President Judson.

(*a*) Yes. (*b*) Yes. (*c*) Yes. (*d*) Nearly so. —President Lowell.

(*a*) They are made so by law. (*b*) In most cases, yes. (*c*) Yes. (*d*) We have no such cases. —President Bryan.

(*a*) Not members of university legislating bodies. (*b*) Presumably they have a voice in departmental matters, though it can not be said that there is uniformity of practise in the different departments. (*c*) May be appointed, but such appointments are rare. (*d*) Occasionally made acting heads of departments. This is only on occasions when there is no one of rank of professor in the department.—President MacLean.

(*a*) Are members of the faculties of their schools, but not of the university council. (*b*) Yes. (*c*) Theoretically, yes. (*d*) No.—Dean Templin.

(*a*) Are members of faculty. New appointees are not admitted to council until the end of three years. (*b*) Yes, by regulations. (*c*) All mem-

bers of council eligible to all committees. The advisory board, however, is elected by the council from the full professors only. (*d*) Have been sometimes acting heads, where there was no full professor.—Stanford.

(*a*) Faculty, yes. Council, no. (*b*) Subject to the head of the department. (*c*) Yes. (*d*) If there is a head professor, he is head. If there is none, an assistant professor in the department may act as head.—President Northrop.

(*a*) Yes. (*b*) They are supposed to have, and our policy is to give them, equal voice with full professors. (*c*) Yes. (*d*) They have not been in the past, but I have positively committed my administration to an affirmative answer to this question for the future. I have had no new permanent heads of departments appointed, and shall not hesitate to appoint assistant professors.—President Hill.

(*a*) Yes. (*b*) Yes. (*c*) Yes. (*d*) Yes as to law, but not as a matter of practise.—President Van Hise.

(*a*) They are members of the faculty and have votes in all administrative matters; but they are not as a rule members of the higher bodies that deal with legislation in the narrower sense. (*b*) Yes. (*c*) Practically so, except as the greater experience of full professors creates a greater demand for their services on committees. (*d*) No. It is only in exceptional cases that an assistant professor becomes an executive head of a department.—President Hadley.

Question 5*e* asked whether it was advisable for the younger men of an institution to take an active part in forming and executing its policies, and if so, why.

The replies:

Yes. For their own development, and to prevent the undue conservatism of age.—President Judson.

Yes. Because he is more apt to be progressive. —President Lowell.

Yes, assuming that the younger men are on the average equal in ability to the older, they have the advantages of their youth in terms of spontaneity and energy, and these should not be lost to the university.—President Bryan.

I think it advisable. With the balance given by the older men of the faculty the university has the advantage of the strength and activity of the younger men, without the danger of their forcing wrong policies on the institution through lack of judgment. Their recognition as a part of the administrative machinery, which does not exist if the younger men are not taken into the administrative counsels.—President MacLean.

Yes, to promote progress.—Dean Templin.

Yes, in order to realize their difficulties. But they should not be too zealous before studying problems.—President Jordan.

Yes. Because the institution may profit by the best thought of all—and the younger men sometimes know more than the older.—President Northrop.

I do. Because they can often render valuable services, and because they thus become more serviceable, more loyal to the institution, and find greater satisfaction in their work.—President Hill.

Yes. Advantageous to have them consider themselves as part of the institution in the full sense. —President Van Hise.

Yes. I regard it as self-evident.—President Hadley.

Query 5*f* asked whether it was desirable to have departments conducted on a democratic or autocratic basis.

The replies:

A qualified democracy is the better.—President Judson.

Democratic.—President Lowell.

Autocracy means, as a rule, more immediate efficiency. Democracy of the right sort means lasting health in the organization, with all the good consequences which flow therefrom.—President Bryan.

It is desirable that departments be conducted on a democratic basis.—President MacLean.

Neither. Republican rather.—Dean Templin.

Democratic in so far as experience and circumstances permit.—President Jordan.

Democratic with a *head*.—President Northrop.

Democratic.—President Hill.

Democratic.—President Van Hise.

It depends wholly upon the men you have on the staff. If the president is wise and the rest of the teaching force foolish, it is desirable that it should be autocratic. If the president is foolish and the rest of the teaching force are wise, it is desirable that it should be democratic.—President Hadley.

To the request for suggestions concerning the problem of the assistant professorship, looking toward higher individual or institutional efficiency, there was much more reticence on the part of the presi-

dents than on the part of the assistant professors. Two replies only were received. Fortunately, they sum up the conclusions most adequately:

The principle ought to be established that "there is always room at the top." Under an autocratic system or even where permanent appointments are made of "heads of departments," there is never room at the top. A more democratic organization of department faculties seems to me to be one of the most important and pressing reforms demanded in educational institutions. —President Hill.

Better pay: greater insistence on superior life —which involves zeal, character, interest in students, interest in knowledge and ability to distinguish scholarship from pedantry.—President Jordan.

The writer's task is completed. For the opportunity offered him to prepare this paper, and to all those who burdened themselves with so thoroughly answering his many questions, he wishes to express his grateful thanks. He has made no attempt to trace the historical development of the assistant professorship in the American university system, nor to disentangle the combinations of regular and acting, adjuncts, assistants, associates and juniors where these exist,[13] nor to show the possibilities of university teaching as a career. He has merely tried to present a faithful cross-section of the existing conditions of the assistant professorship in the institutions represented in this association.

Both sides have been heard; their conclusions are in striking accord. The initiative for improved administrative status and adequate salaries lies in the hands of the one; that for increased zeal, worth and efficiency in the hands of the other. The outlook is full of opportunity and promise.

GUIDO H. MARX

[13] One institution has twenty regular titles in its list of staff.

APPENDIX A

QUERIES FOR ASSISTANT PROFESSORS

Suggestions and comments on points not covered below will be gratefully received.

1. Age?
2. Degrees?
3. Years spent in collegiate and graduate (or professional) study?
4. To what extent did you hold fellowships or receive similar assistance?
5. To what extent did you go into debt for your training?
6. How long did it take to pay this debt?
7. Length of teaching service below rank of assistant professor?
8. Length of teaching service in rank of assistant professor?
9. Married or single?
10. Number of children?
11. Present salary?
12. Average salary during entire teaching service?
13. Total savings from salary (exclusive of insurance)?
14. To what extent have you supplemented your salary by income from other sources?
15. Is your income sufficient to make both ends meet or are you running behind?
16. If willing, will you state your present net deficit or indebtedness?
17. How much insurance do you carry?
18. What are your opinions concerning the status of the assistant professorship (*a*) in sharing in the determination of general policies of your institution; (*b*) in departmental policy, curriculum and assignment of courses; (*c*) in conduct (*i. e.*, direction) of individual classes?
19. What are the conditions of nature and amount of work, etc., and do these reasonably favor carrying on advanced work and intellectual growth?
20. What are the conditions governing tenure of the assistant professorship and are they the best for reasonable independence of thought and action?
21. Have you any suggestions to make, concerning the problem of the assistant professorship, looking toward higher individual or institutional efficiency?

APPENDIX B

QUERIES FOR PRESIDENTS

Suggestions and comments on points not covered below will be gratefully received.

1. Kindly fill in this table:

	'89–'90	'99–'00	'09–'10
Number of full professors			
Number of associate "			
Number of assistant "			
Number of instructors			
Number of assistants			
Number of students			

2. *a* Have you formulated any basis of requirements for eligibility to promotion from instructorship to assistant professorship?
   b What would you consider suitable qualifications of age, training, scholarship, teaching ability, experience, etc.?
   c Do you consider the present requirements for the position of assistant professor to be more or less exacting than they were twenty years ago?
3. *a* What are the minimum, maximum and average salaries paid assistant professors of your staff this year?
   b What were these salaries in 1889–1890?
   c From the point of view of the value of their services to the institution, what would you consider a proper ratio between the average salaries of assistant professors and of full professors?
4. *a* Do you recognize two general classes of assistant professors, temporary and permanent; that is, those who may reasonably look forward to promotion and those who, for one reason or another, may not?
   b If conditions tend to form a permanent class of assistant professors, are present ruling salaries adequate for efficient life-service in this rank?
   c What suggestions would you make in regard to meeting the problem of a permanent class of assistant professors?
   d Do you grade assistant professors' salaries at all with respect to length of service?
   e What do you consider essential qualifications for eligibility to promotion from assistant professorship to the rank above?
   f From the point of view of the administration, should length of service constitute any claim for promotion?
   g How long has your senior assistant professor served in this rank?
   h On the average, what percentage of assistant professors are promoted by you each year?
   i Are promotions as rapid or as general as the highest efficiency of the institution demands?
   j If not, what do you consider the chief causes of delay?
5. *a* Are your assistant professors members of the legislating bodies, faculty, council, senate, etc.?
   b Have they a voice in departmental matters?
   c Are they on the same footing as full professors in respect to appointment to administrative and academic committees which formulate, control or direct educational policies?
   d In respect to appointment as executive heads of departments?
   e Do you consider it to be advisable for the younger men of an institution to take an active part in forming and executing its policies? Why?
   f As a matter of the highest efficiency of the institution, do you consider it desirable to have departments conducted on a democratic or autocratic basis?
6. Have you any suggestions to make concerning the problem of the assistant professorship, looking toward higher individual or institutional efficiency?
7. Are you willing to have your name attached to quotations from these answers?

SCIENTIFIC NOTES AND NEWS

MR. ALEXANDER AGASSIZ died on March 28, on the steamship *Adriatic.*

SIR ERNEST SHACKLETON gave an address on his Antarctic explorations before the National Geographic Society on March 26, and was presented with the gold medal of the society by President Taft. On March 28 he addressed the American Geographical Society in New York City and received its gold medal.

THE date for the delivery of the Romanes lecture at Oxford University by Mr. Roosevelt has been fixed for Wednesday, May 18.

AT the annual meeting of the Institution of Mining and Metallurgy in London, on March 17, the following awards were presented: the gold medal of the institution to Professor William Gowland, the "Consolidated Gold Fields of South Africa," gold medal to Mr. W. A. Caldecott and the premium to Mr. C. O. Bannister and Mr. W. N. Stanley.

In a convocation at Oxford on March 15 a decree was passed unanimously, on the motion of Professor Elliott, conferring the title of professor emeritus on Edward Burnett Tylor, M.A., Hon. D.C.L., honorary fellow of Balliol College, who on December 31 last resigned the office of professor and reader in anthropology after a tenure of twenty-six years.

Dr. Alexander C. Abbott, of the University of Pennsylvania, has been selected as a delegate to the International Congress of Hygiene and Medicine, which meets in Buenos Ayres, Argentine Republic, next month.

Dr. E. E. Southard, of the Harvard Medical School, has been appointed by President W. C. Gorgas a member of the council on medical education of the American Medical Association, to fill the unexpired term of Dr. W. T. Councilman.

At the annual meeting of the Ray Society held in London on March 10, Lord Avebury, F.R.S., was reelected president; Dr. S. F. Harmer, F.R.S., was elected a vice-president; Mr. F. DuCane Godman, F.R.S., was reelected treasurer, and Mr. John Hopkinson was elected secretary.

Dr. Sambon has been sent to Italy by the Pellagra Investigation Committee. Captain Siler, U. S. A., has been officially welcomed as a member of the field commission, and two assistants, Messrs. Baldini and Amoruso, have been appointed.

Dr. Henry S. Pratt, professor of zoology at Haverford College, will spend next year in foreign zoological laboratories.

It is reported that Captain Amundsen has modified his plans to the extent of postponing his departure from Norway till June of this year, and his final passage of Bering Strait till August, 1911, devoting most of the intervening period to oceanographical research in the South Atlantic during the outward voyage. He also proposes to carry out extensive investigations of the upper atmosphere during the drift across the Polar basin.

Dr. Maurice Vejux Tyrode, faculty instructor in pharmacology in the Harvard Medical School, has presented his resignation to take effect on September 1, 1910.

Professor Leonard P. Kinnicutt, of the department of chemistry of the Worcester Polytechnic Institute, on February 18, gave a talk to the students of Union College and the Engineering and Chemical Societies of Schenectady on the "Bacterial Methods of Sewage Disposal."

Professor G. H. Parker, of Harvard University, lectured on March 4, before the Buffalo Society of Natural History on "The Structure and Origin of Coral Islands."

Mr. Cyrus C. Adams, of the American Geographical Society, gave a lecture on "Arctic Exploration," before the geological department of Colgate University, on March 21.

There was on March 25 and 26 at the State University of Iowa a joint meeting of the Western Philosophical Association, the North Central Section of the American Psychological Association and the Teachers of Psychology in Iowa. The address of the president of the Western Philosophical Association, Professor Carl E. Seashore, was on the "Rôle of Play in Religion."

At the annual general meeting of the Society of Dyers and Colorists held at Manchester, on March 18, the retiring president, Professor R. Meldola, F.R.S., delivered an address on "Tinctorial Chemistry—Ancient and Modern." Sir Frederick Cawley has been elected to the presidency.

At the annual meeting of the Chemical Society, London, on March 18, the president, Professor Harold B. Dickson, F.R.S., made an address on "The Union of Hydrogen and Oxygen in Flame."

The fourth annual meeting of the British Science Guild was held at the Mansion House, London, on March 18, under the presidency of the Lord Mayor. Addresses were delivered by the Right Hon. R. B. Haldane, F.R.S., and others.

The seventieth birthday of Ernst Abbe, who died five years ago, has been celebrated at Jena, where it is planned to erect a monument

in honor of his contributions to optical science and his foundation at the university.

The *Journal* of the American Medical Association states that the famous ophthalmologist, Professor Jaeger von Jaxtthal, who died in 1884, has been honored by the erection of a life-sized statue in the hall of the University of Vienna. Professor Fuchs delivered the commemorative address. Jaeger was the son of a famous ophthalmologist: was the grandson, on his mother's side, of the famous ophthalmologist Beer, and was married to the daughter of Arlt, also an eminent ophthalmologist.

Dr. Wharton Sinclair, an eminent neurologist, a trustee of the University of Pennsylvania, died at Philadelphia on March 15.

Henry Augustus Torrey, assistant professor of chemistry at Harvard University and known for his work in organic chemistry, died at Cambridge, on March 26, at the age of thirty-eight years.

Dr. H. Landolt, professor of chemistry at the universities of Berlin and Bonn, eminent for his contributions to physical chemistry, died on March 14 at the age of seventy-eight years.

Professor K. J. Angström, professor of physics in the University of Upsala, died on March 4 at the age of fifty-three years.

Dr. C. Philippi, professor of geology at Jena, has died in Egypt.

M. Youx, professor of mathematics at Paris, has died at the age of eighty-one years.

There will be a civil service examination in New York State on April 23, to fill various positions, including that of medical superintendent of Letchworth Village, the new state institution for the feeble-minded and epileptic. The salary of this position is $4,500 with maintenance for the superintendent and his family.

King Albert of Belgium will give $200,000 for investigations into the nature and prevention of sleeping sickness. He will also give $100,000 for hospitals for natives of the Congo.

Carrimbhoy Ebrahim has given to the Bombay government a sum of $150,000 for research and the provision of scholarships to science students of the Mussulman faith.

The seventh International Congress of Criminal Anthropology, which was to have been held at Cologne in August next, has been postponed till October, 1911.

The third International Congress of School Hygiene will be held at Paris from August 2 to 7, under the honorary presidency of the minister of public instruction. The subjects selected for discussion at the general meetings are: "Physical examinations in schools"; "Sexual education and school physicians." The congress will further meet in eleven sections for the discussion of various topics in school hygiene. Especial reductions are given by the railways and steamships, and visits to schools and other excursions have been organized. The circular of information further says: "Nothing will be spared to make the stay in Paris easy to the congressists." The secretary of the congress is Dr. Dufestel, 10 Boulevard Magenta, Paris.

At the regular weekly meetings of the University of Colorado Scientific Society the following scientific addresses have been given during the months of December, January, February and March: "Liquid Air and Low Temperature Phenomena," Professor Walter Runge and Mr. Harry A. Curtis; "Scientific Stories," Professor S. Epsteen; "Some Recent University Expeditions with special reference to Northwestern Colorado," Professor Junius Henderson; "The Electrolytic Determination of Metals, using Rotating Anode," Mr. Harry A. Curtis; "Relation between Climate and Crops in Colorado with special reference to Unsolved Problems," Mr. Wilfred W. Robbins; "The British Association in South Africa," Professor Henry Carhart; "Tree Planting for Colorado," Mr. D. M. Andrews; "Mysticism and Modern Psychology," Professor V. A. C. Henmon; "Real Color Photography Direct from Nature," Mr. Stanley McGinnis.

The deans of the colleges of liberal arts of the state universities of the middle west were

in session at the University of Illinois on March 23 and 24. Those in attendance and the papers that they read at this conference were: Dean Davis, of Nebraska, "Incentives to Scholarships"; Dean Jones, of Missouri, "Systems of Grading"; Dean Hoffman, of Indiana, "What can be done for the Freshmen"; Dean Townsend, of Illinois, "Faculty Advisers"; Dean Reed, of Michigan, "What should be done with Large Classes"; Dean Downey, of Minnesota, "Group Requirements for the A.B. Degree"; Dean Greene, of Illinois, "The Future of the A.B. Degree"; Dean Templin, of Kansas, "The College and the Professional Schools"; Dean Birge, of Wisconsin, "The Building of a Faculty." Assistant Deans Rawles, of Indiana and Meyer, of Illinois, were also in attendance.

UNIVERSITY AND EDUCATIONAL NEWS

HAVERFORD COLLEGE has completed the collection of a fund for pensions amounting to about $150,000.

SIR FRANCIS GALTON has made a further donation of £500 for the maintenance of the Francis Galton Laboratory for the Study of National Eugenics in the University of London during the year 1911–12.

VIVIAN A. C. HENMON, A.B. (Bethany), Ph.D. (Columbia), now professor in the University of Colorado and dean, has been elected associate professor of educational psychology in the University of Wisconsin.

R. M. OGDEN, A.B. (Cornell), Ph.D. (Würzburg), has been promoted to a professorship of philosophy and psychology in the University of Tennessee.

DR. A. G. G. RICHARDSON has been elected professor of veterinary medicine of the Georgia State College of Agriculture. Dr. Richardson was in the United States Bureau of Animal Industry for a number of years.

DR. A. O. SHAKLEE, assistant in physiology and pharmacology of the Rockefeller Institute, has accepted the position of associate professor of pharmacology in the Philippine Medical School, Manila. Mr. Elbert Clark, associate in anatomy in the University of Chicago and Rush Medical College, has been appointed assistant professor of anatomy at Manila.

PROFESSOR WILLIAM MOORE, of Cornell University, has received an appointment to a chair in the faculty of the British Agricultural College in the Transvaal.

SIR ALFRED KEOGH, K.C.B., who has been elected rector of the Imperial College of Science and Technology, London, retired last year from the post of director-general of the Army Medical Service.

DISCUSSION AND CORRESPONDENCE

FRACASTORIUS, ATHANASIUS KIRCHER AND THE GERM THEORY OF DISEASE

IN SCIENCE for February 18, Dr. William A. Riley gives a clear and interesting account of the relation of Athanasius Kircher to the germ theory of disease. In connection with this paper it may be of moment to note that, as Osler has pointed out,[1] the true author of the germ theory is neither Kircher nor Hieronymus Mercurialis, but Fracastorius, a Veronese physician of the fifteenth century, whose chief title to fame has been hitherto that "most popular" of medical poems, if least savory in theme, "Syphilis, sive morbus gallicus" (1530). Geronimo Fracastorio, born in 1484, studied medicine at Padua, led a tranquil, easy life as physician and poet in the countryside near the Lago di Garda, and died in 1553. His work "De contagione et contagiosis morbis et curatione," published at Venice in 1546, contains the first scientific statement of the true nature of contagion, of infection, of disease germs and the modes of transmission of infectious diseases. The latter he divides into (1) diseases infecting by immediate contact (true contagions), (2) diseases infecting through intermediate agents like fomites, (3) diseases infecting at a distance or through the air, of which class he instances phthisis, the pestilential fevers, a certain kind of ophthalmia (conjunctivitis),

[1] *Proceedings of the Charaka Club*, New York, 1906, II., 8–11.

etc. In all this Fracastorius shows himself to be a highly original thinker, far in advance of the pathological knowledge of his time, which was mainly reducible to the old Hippocratic doctrine of disease as a corruption of the humors of the body. But it is in his remarkable account of the true nature of disease germs, or *seminaria contagionum*, as he calls them, that we find him towering above his contemporaries. He seems, by some remarkable power of divination or clairvoyance, to have seen morbid processes in terms of bacteriology more than a hundred years before Kircher, Leeuwenhoek and the other men who worked with magnifying glass or microscope. These germs he describes as particles too small to be apprehended by our senses (*particulæ illæ insensibiles*), but which, in appropriate media, are capable of reproduction and thus of infecting the surrounding tissues (*prima enim seminaria, quæ adhæserunt e vicinis humoribus ad quos habent analogiam consimilia sibi alia generant et propagant, et hæc alia donec tota humorum massa et moles afficiuntur*). These pathogenic units Fracastorius clearly surmises to be of the nature of colloidal systems, for if they were not viscous or glutinous by nature, he holds, they could not be transmitted by fomites (*cujus signum est, quod quæcunque per fomitem afficiunt omnia lenta glutinosaque conspiciuntur*); while germs transmitting disease at a distance must be able to live in the air a certain length of time (*non solum in fomite sed in aere per certum tempus servari*), and this condition is only possible when the germs are gelatinous or colloidal systems; for only hard, inert, discrete particles could endure longer (*sed certe, quæ lenta sunt et glutinosa, quamquam parvissima sint, possunt quidem si non omnino tantum quantum dura, vivere, at paulo minus possunt*). These colloidal particles have the power of resisting forces of small magnitude, but can not resist such agencies as extremes of heat or cold, which reduce them to phases of dissipated energy (*non solum dura, sed et lenta sese defendunt ab alterationibus multis, si mediocres sint, magnas autem non ferunt: propter quod et ab igne absumuntur seminaria omnium contagionum, et ab aqua etiam frigidissima franguntur*). Finally Fracastorius conceives that the germs become pathogenic through the action of animal heat (*et ipsa actu fiunt a calore animalis*), and that in order to produce disease it is not necessary for them to undergo dissolution, but only metabolic change (*quantum quidem sufficit ad putrefactionem faciendam, non necesse esse corrumpi particulas ipsas, sed alterari solum . . . nihil tamen prohibet et corrumpi etiam, sed non necesse est, quatenus attinet ad faciendam putrefactionem*). Thus Fracastorius seems to have had a clear notion (or prevision) of the causation of disease by microorganisms, and he appears to have seen these organisms as made up of those gelatinous or "dispersed" systems which modern physical chemists call colloidal states of substance. The agreement of his imaginative hypothesis with the physicochemical view-point is little short of wonderful, when we consider that he had no microscope nor other instrument of precision save his own mind.

In referring to the organisms seen by Kircher, Dr. Riley asserts that he must have seen "the larger species of bacteria" long before Leeuwenhoek's discovery. But neither Kircher nor Leeuwenhoek could have seen bacteria of any kind with the lenses at their command, although the latter undoubtedly saw various animalculæ, diatoms, blood corpuscles and the finer anatomy of the tissues. According to Müller and Prausnitz,[2] Kircher saw in the blood of plague patients "a countless brood of worms not perceptible to the naked eye," and he was not staggered by the fact that these "worms" could also be found in healthy blood. The explanation is simple. His glass or microscope was only 32-power at best, and the worms he thought he saw were (as in Malpighi's case) simply rouleaux of red blood corpuscles.

To sum up, over one hundred years before Kircher, Fracastorius gave the first definite statement of the true nature of infection by disease germs; Kircher then boldly restated

[2] "Handbuch der Geschichte der Medizin," Jena, 1905, II., 805.

the hypothesis in the light of what he saw through the microscope, but the germ theory had to wait for laboratory verification at the hands of Pasteur. In connection with the theory of the transmission of disease by insects it is of interest to note that Sir Henry A. Blake, governor of Ceylon, has pointed out[8] that the mosquito theory of the origin of malaria is as ancient as the Susruta, a Sanskrit medical classic at least 1,400 years old. Quite an anthology might be compiled of references from secular literature in which swamps, mosquitoes and malaria were vaguely associated as if in causal connection before King enunciated the theory in 1882. But no one ever thought of mosquitoes in relation to yellow fever before the time of Finlay and Walter Reed.

Fielding H. Garrison
Army Medical Museum

[8] *Jour. Ceylon Branch Brit. Med. Assoc.*, Colombo, 1905, II., 9.

THE LOWER TERTIARIES OF LOUISIANA

To the Editor of Science: In preparing manuscript for publication on the lower Tertiaries of Louisiana it has seemed desirable to have a formational name for that portion of the Eocene usually styled in our former publications "Lower Claiborne." In accordance with the wishes of the committee on nomenclature the geographic name *St. Maurice* is here proposed for these well-known Mississippi embayment marine beds.

G. D. Harris

THE LENGTH OF SERVICE PENSIONS OF THE CARNEGIE FOUNDATION

The articles by Professors Cattell and Jastrow following that of Professor Lovejoy and the *Nation* editorial, have put in such strong light the disadvantages and the injustice of the recent ruling by the Carnegie Retiring Board, that it might seem little remains to be said. There can be little doubt that these articles express the sentiment of a great majority among those who have been looking forward to a service retiring allowance upon the Carnegie Foundation. Some professors who have considered the system a great aid in securing stronger American universities, have now lost all interest in it. If a professor who entered early upon teaching must continue for forty years as a professor in order to acquire any benefits from the foundation, not much inducement is offered him.

There are, as it seems to me, two considerations not specially emphasized in the articles cited, which might well be taken up. In his report recently published, the president of the foundation lays stress upon the fact that the professors thus far retired upon the foundation because of age, all laid down their work with regret, and in some cases felt hurt that they had been induced to do so. No one familiar with university men will for a moment doubt that these statements represent the facts as regards an even larger body of the older professors. Among the middle-aged and young men of universities, and it might be added the student body, the opinion is probably as general that professors generally remain at their posts after their best work of teaching has passed. This opinion of the younger men does not spring altogether from a selfish desire to fill the positions of their seniors, since their conclusion expresses a law of human nature which is exemplified in every walk of life, but perhaps most strikingly upon the concert stage. When nowadays a young man states openly that he will retire from his post voluntarily before his powers have been impaired by age, he is perhaps cynically requested to set the statement down in writing; for, once admitted into the group of the older men, it is notorious that he acquires their point of view as naturally as liberals become transformed into conservatives after their admission to the British House of Lords.

The question of the relative teaching efficiency of professors at the different ages between forty and seventy-five years, is one to be decided by results, and it would be of special interest if the statistics recently gathered by the Carnegie Foundation from the so-called accepted institutions were compared and published. If the average age of the

teachers in each grade of university work were made public for each of the institutions in question, the reader might then draw his own conclusions based upon the relative standings of the institutions.

Aside from personal observation, there are two reasons which make it unlikely that the best work of a teacher should extend beyond a moderate term of years. In the first place, the world moves forward so rapidly that in a period of thirty-five or forty years, methods, view-points and subject-matter of the sciences are all more or less transformed. Few of our universities provide a sabbatical year in which the opportunity is offered the professor to make himself over, even if he be constructed of sufficiently plastic materials. In the second place, few men can go year after year over the same tasks without reaching a condition which in the athlete would be designated "stale." The enthusiasm of earlier years is bound to become more or less dulled, and enthusiasm and interest are vital elements to the teacher.

There is another important function of the teacher which should be carefully brought into consideration, for an insidious encroachment has been made upon it during the past decade. I refer to research, which, it will generally be admitted, should in every possible way be encouraged in the university professor. There is no really great university that has not done its part in widening the horizon of the known through the investigations by its professors. It might be safely predicted that a university which relinquished altogether this function would speedily degenerate to an inferior rank. The spirit of inquiry and of testing conclusions is, in fact, that which differentiates higher instruction from that of lower grade. It may not be generally recognized, but it seems to be true that in respect to research the American universities are to-day in a somewhat critical position as a result of the great fortunes built up through consolidation of business interests. American research is fast becoming institutional. It will probably have to be admitted that the immediate results have been so much the more increased, even though the universities have suffered by it. The enlargement of government and state scientific bureaus, the private foundation of great laboratories in the interest of medical science, and the laboratories of practical science established in connection with the great industrial concerns, have withdrawn from the universities many of the men who have made reputations by their researches. To some of those that remain the Carnegie Institution of Washington has offered some advantages, but the avowed policy of that institution is now to centralize its work more and more in the city of Washington and in its own special laboratories.

The problem thus thrust upon the universities is one that they can not afford to ignore, since it is not always easy to convince boards of regents or trustees that a professor is filling his chair with credit when a considerable portion of his time is devoted to purely research work. The service pension of the Carnegie Foundation, while not offering a full solution of this problem, had yet made the outlook more promising. If it be true that the average professor between the ages of fifty-five and sixty-five is on the whole less efficient as a teacher than the man ten years his junior, I believe that as regards research the reverse would more nearly represent the facts. Most men who have gone far in investigation have begun with smaller problems the original study of which has suggested kindred questions, so that as they have advanced the field of their studies has constantly widened until far more general and fundamental questions have been forced upon the attention and been made the subjects of inquiry. Thus the ripe period from fifty to sixty-five years of age is with little doubt the one which under favorable conditions offers the greatest opportunities for research. A paragraph in President Pritchett's letter of April 24, 1908, shows his appreciation of the opportunities the universities would secure if professors retired upon service pensions could continue their work in research upon the grounds of the university:

I can imagine no better thing for an institution of learning than to have about it a group of men who are engaged in active research and who are not burdened with the load of teaching which

falls to most American teachers. In this way the retiring allowance will contribute directly to research.

The abuses which, it is intimated, have led to the withdrawal of the service pension, seem to have been on the whole far less serious than has been assumed. The forcing of professors of long service to resign their positions has generally carried with it such danger to the president's own tenure of office that it has rarely been undertaken. There has been additional difficulty in that an aged professor whose efficiency had been impaired would be left without adequate financial support though fully deserving of rewards upon the basis of his earlier work. With the service pension provision withdrawn it will now be incumbent upon university presidents to retain upon their staffs all professors not physically disabled up to the age of sixty-five, no matter what may be their efficiency as teachers. It can hardly be doubted that the effect will be to lower the efficiency of teaching in the universities.

Wm. Herbert Hobbs

University of Michigan,
March 15, 1910

SCIENTIFIC BOOKS

The Oxidases and other Oxygen Catalysts concerned in Biological Oxidations. By J. H. Kastle. Hygienic Laboratory Bulletin No. 59, December, 1909.

The bulletins issued by the Hygienic Laboratory at Washington constitute a most interesting and valuable series of contributions which reflect the greatest credit upon the organization and spirit of this important department of the Public Health and Marine Hospital Service. For the most part these publications consist of experimental researches dealing with topics of timely interest to physicians and biologists in general, while some of them are of the nature of résumés of the literature and the condition of our knowledge in regard to special problems. The bulletin to which attention is called here belongs to this latter class. It contains an elaborate and thorough review of the history and present status of the difficult and complex subject of oxidations particularly as they occur in living things. Since this review is written by one who himself has been a distinguished contributor to the experimental investigation of the subject it possesses the additional value of being an authoritative presentation which other biologists may use with a feeling of confidence in its accuracy. Professor Kastle modestly disclaims any pretention to completeness as regards the literature consulted in the preparation of the bulletin, but it will be noted that four hundred and sixty-seven references are given in the appended bibliography, and those who read the contribution will be impressed with the fact that the author writes out of an unusual fullness of knowledge of the subject in its chemical as well as its biological bearings. After the discovery of oxygen by Lavoisier the history of the attempts made to disclose the nature of the processes involved in the physiological oxidations of plants and animals may be divided, according to Kastle, into three periods. The first of these deals with the bluing of guaiacum, especially by extracts of plant tissues. The names that are important in this connection are Planche, Taddei and particularly Schoenbein. The last-named observer studied the subject from many sides and arrived at a clear understanding of the fact that plants and animals contain special substances, destroyed at temperatures below that of boiling water, which have the property of combining with atmospheric oxygen and activating it so that it is capable of effecting the wonderful oxidations characteristic of living things. Schoenbein himself believed that these substances render the oxygen active by ozonizing it, but this view has not been confirmed by subsequent work. The second period is connected with the work of Traube, who was responsible for emphasizing the importance of hydrogen peroxide in all oxidations, including those of living things. His peroxide theory as developed later by Bach, Engler and others does not assume that hydrogen peroxide itself is formed in the processes of physiological oxidations, but that the organic substances which combine with the oxygen, designated

by Traube as oxidizing ferments, form compounds of the nature of peroxides which promote and accelerate the oxidation of other substances. This view may be represented in its simplest form by the two following equations in which A constitutes the oxidizing ferment and B the substance whose oxidation is effected through the agency of this ferment:

$$A + O_2 = AO_2$$
$$AO_2 + B = AO + BO$$

The third period considered by the author extends to the present time and begins with the work of Yoshida, Bertrand and others upon specific oxidases, particularly upon laccase and tyrosinase. The very interesting literature upon these and related oxidases is reviewed at length, and the author suggests the following classification of the oxidases as being in accord with our present knowledge:

1. Laccase; ferments oxidizing guaiacum, guaiacol, hydroquinone, phenolphthalin, tannin, etc., directly by means of atmospheric or dissolved oxygen, and without the intervention of hydrogen peroxide.

2. Tyrosinase; ferments acting on tyrosin and related substances, and responsible possibly for the production of melanin and other pigments in plants and animals.

3. Aldehydases; ferments oxidizing aromatic aldehydes and related compounds.

4. Indophenol oxidase; ferments oxidizing a mixture of α-naphthol and para-phenylene diamine to indophenol.

5. The purin oxidases.

6. The glycolytic ferments, causing the disappearance of sugar from animal tissues.

Closely related to these oxidases are the following catalytic agents which act in conjunction with hydrogen peroxide or related organic peroxides:

1. Peroxidases; ferments which exert an oxidizing reaction only in the presence of a peroxide, such as hydrogen peroxide.

2. Catalases; ferments which actively decompose hydrogen peroxide.

3. Oxygen carriers (not true ferments); this class includes substances such as hemoglobin and hemocyanin which are capable of activating the oxygen of hydrogen peroxide, even after their solutions have been heated to 100° C.

This classification brings up the perplexing question of the distinction made between the oxidases and peroxidases. According to the well-known views of Bach and Chodat all oxygen-activating ferments are really peroxidases. So-called oxidases, such as laccase and tyrosinase, consist of certain substances (oxygenases) capable of forming with oxygen unstable compounds of the nature of peroxides. The oxygen in these peroxides is rendered active by the ferment bodies designated as peroxidases. Laccase differs from tyrosinase in the specific nature of the constituent peroxidase. Kastle evidently does not hold to this or similar views, but recognizes the existence of at least two classes of oxidizing ferments, the oxidases and the peroxidases, as defined in the classification given above. As far as the peroxidases are concerned, he conceives that they are substances which are capable of producing peroxides either by double decomposition with hydrogen peroxide, or by forming an unstable addition product with hydrogen peroxide. These two possible reactions and the resulting activation of the oxygen are indicated schematically in the following equations in which P represents a peroxidase:

$$(1) \quad P + H_2O_2 = PO_2 + H_2O$$
$$PO_2 + B = BO + PO, \quad \text{or}$$
$$PO_2 + 2B = P + 2BO$$

$$(2) \quad P + H_2O_2 = H_2PO_2$$
$$H_2PO_2 + B = P + BO + H_2O$$

Kastle emphasizes the fact that the peroxidase reaction, as also the catalase reaction, constitutes one of the most universal and persistent properties of living tissues. When these reactions fail there can be no question that the tissue or organism concerned is dead.

In other sections of the review the author treats of the oxygen catalysts of blood in health and disease; of the very interesting discoveries in regard to the part taken by certain metals such as manganese, copper and iron in the activity of the oxidases and the peroxidases, and of the suggestive work done

upon the production of artificial oxidases; of the nature and supposed functional importance of the catalases, etc. It would be scarcely possible in fact to enumerate in a brief notice all of the important points which are discussed and reviewed. The author has laid his fellow biologists, who may be concerned in understanding the nature of physiological oxidations, under a debt of gratitude for his able and exhaustive presentation of this difficult subject. We can only wish that with his own extensive first-hand knowledge of the facts he had attempted to winnow from the great mass of contradictory or divergent observations those that to him might seem to be entitled to at least provisional acceptance at the present time. The reader who is not a specialist in this line of work is somewhat at a loss to appreciate how the balance of evidence tends in regard to many of the disputed points.

W. H. Howell

The Evolution of Worlds. By Percival Lowell. Pp. xiii + 262; 12 plates and 56 text cuts. New York, The Macmillan Company. 1909. $2.50 net.

This work is written in the well-known attractive style of the author. It is interesting and will probably fascinate and charm many readers of popular science. Its charm, however, lies in the literary skill of the author, in the attractiveness with which the book is manufactured, in the heavy paper, its clear type and its beautiful illustrations. As a work of art the book is charming and valuable; as an exposition of scientific facts and theories it is exasperating.

The theme of the book is the evolution of the solar system, the process by which the planets came into existence, the phases through which the world has passed, and through which it is destined to pass. Ever since Laplace, in 1796, formulated and published the nebular hypothesis, the subject of the birth, growth and death of worlds has aroused great interest and has attracted many able investigators. For nearly one hundred years the beautiful and simple theory of Laplace was accepted in its entirety by scientific writers. During the last quarter of a century, however, much has been learned concerning the present condition of the solar system, and many facts have been developed which, while establishing the broad underlying idea of planetary evolution, can not be reconciled with the simple Laplacian hypothesis. Sir George Darwin accepted the main outlines of the nebular hypothesis and accounted for the discrepancies between theory and fact by the agency of tidal friction. But there are limits to the potency of tidal friction and even in its modified form the nebular hypothesis fails to account in a satisfactory manner for all the complicated details of the solar system.

Within comparatively recent years Chamberlin and Moulton have advanced what is called the "planetesimal" or "spiral" hypothesis. It explains many of the difficulties encountered by the Laplacian or nebular hypothesis and is undoubtedly the most satisfactory working theory yet advanced. Their first papers were published as early as 1900, since which date they have from time to time elaborated and developed their theory.

Now, Lowell's book, in its main features, is an exposition of the "planetesimal" theory, but an exposition with no reference to, or mention of, the work of Chamberlin or Moulton. It is like the play of Hamlet with Hamlet left out. Neither Chamberlin's nor Moulton's name appears in the index, nor, in a careful reading of the book, do we find any mention of them or of "planetesimal" or "spiral" hypothesis. This is not so strange as at first glance it might appear, for Professor Lowell has recently attacked the scientific value of the theory and the standing of its authors. In the *Atlantic Monthly* for August, 1909, Lowell refers, in a foot note, to Chamberlin and the planetesimal theory in the following words: "Astronomically he is unaware that what prompted his contention, the planetesimal hypothesis, is *mathematically unsound.*" The publication of the "Evolution of Worlds," with its nameless presentation of the planetesimal hypothesis, shows that while Lowell appreciates the fundamental correct-

ness of the theory and its value as a working hypothesis, he is unwilling to admit his former error and to give to true scientific workers the credit which justly belongs to them.

This obvious attempt at consistency on Professor Lowell's part is rather belated, for, as a rule, inconsistencies do not bother him. His books are full of them. He is so interested in marshaling his facts and proving the point at immediate issue, that he appears to forget that at some other time, in some other place, he has arrayed the same facts differently and by them proved the exact opposite. In order to prove, for example, that certain dark lines, which appear in his drawings of Venus, really exist and form permanent markings on this planet, Lowell argues, against the evidence of other investigators, that Venus is surrounded by a very thin atmosphere, "gauze of the most attenuated character"—that the brilliancy of the planet is due to this very thinness of atmosphere. In another chapter Lowell finds the brilliancy of Jupiter and Saturn mostly due to dense cloud forms in their atmospheres. On the one hand, Venus has no clouds because she is bright, while on the other hand, Jupiter and Saturn are bright because of clouds. Again these same markings, or pseudo-markings, on the disc of Venus have been variously described by Lowell in his different papers and books.

The book contains many loose statements of scientific facts and principles, and conclusions are drawn by special pleadings and by apt illustrations rather than by any course of logical reasoning. Yet with all this, and in spite of exaggerations and obvious attempts to create popular excitement, the book gives the general reader, in an attractive form, a more or less accurate conception of the latest ideas in regard to the evolution of our world. It is a pity that the work of such a brilliant writer should be marred by his all too evident faults.

CHAS. LANE POOR

Aerial Navigation of To-day; a Popular Account of the Evolution of Aeronautics. By CHARLES C. TURNER. Philadelphia, J. B. Lippincott Co. 1910. 8vo, pp. 327. Illustrated.

This book, which is one of the few of its kind in the English language, was brought out simultaneously last autumn in this country and in England. Its English author shows his predilection in ways hereafter mentioned, but, while he has made some long balloon voyages he modestly refrains from obtruding them upon the reader, unlike most writers of books upon aeronautics, who usually emphasize the particular subject with which they are most familiar. The reviewer himself is no exception, since in his "Conquest of the Air," a smaller contemporary work, of similar scope to the one under consideration, he gives first place to his own explorations in the element that man has conquered after so long a struggle. Mr. Turner begins with a history of ballooning and the principles involved in both spherical and dirigible balloons, mechanical flight being treated in the same way. There follows a chapter on the aerial ocean, which is a compilation of observations by European aerologists, often without context or sufficient explanation. The remaining chapters discuss the applications of aerial navigation and its possibilities, especially in warfare. Rather out of place is the concluding chapter on typical flying machines and dirigible balloons. "Useful tables," a useless glossary of English and French aeronautical terms and a very inadequate bibliography occupy the remainder of the 321 pages. The book is clearly written, profusely illustrated with pictures and diagrams and gives a good idea of the past history and present status of aeronautics. The sanguine prophecies of its future development recall the extravagant and unrealized hopes which were indulged in when the balloon was invented and render the adage, "never prophesy unless you know," a particularly safe one to follow as regards this new art.

No book of the kind can be entirely free from mistakes, but it would seem that the editor of *Aeronautics,* who read the MS. and, to quote the author, "than whom there is no

better authority," should have perceived a good many errors of omission and commission.

Not even in England do authorities now maintain that Glaisher and Coxwell reached the height of 7 miles, as stated on pages 31 and 160, so that the record of 34,400 feet belongs to Berson and Süring, in Germany, and the balloon "Preussen," holding 300,000 cubic feet of gas, in which they ascended, is much larger than the French "Géant," said on page 33 to be the largest free balloon ever constructed. In the table of long balloon voyages, the distance of 872 miles traveled by Erbslöh and Clayton during the Gordon-Bennett race from St. Louis in 1907 is ignored, although shorter voyages in Europe during the same year are enumerated. There are inaccuracies also in the table of early air-ships, for the speed of the first successful dirigible balloon of Renard and Krebs was 14 miles per hour and not 7½ miles, and Santos-Dumont won the Deutsch prize, by circling the Eiffel Tower, in 1901, and not in 1898. As regards the first mechanical flights it is wrong to say on page 81 that the flights of Farman and Delagrange in 1907–8 "were being eclipsed in America by the Brothers Wright," when the latter had made longer flights several years before. The Malay kite (page 96) is not analogous to the "finbat," since it has no plane projecting at right angles from the middle. Hargrave's kite is correctly described, as is rarely the case, in having no continuous corner sticks which were added by Clayton. The Wright aeroplane does not start on a *declined* rail (page 153). Exceptions can be taken to some of the meteorological conclusions, *e. g.*, that the seasonal and daily changes of temperature are much less at an altitude of 5,000 feet than at the ground, because the contrary has been found by the Blue Hill observations. The statement that an Englishman, Archibald, first used kites to lift automatic registering instruments, on page 158, apparently contradicts one on page 94 that in 1894, for the first time, automatic recording apparatus was sent up on kites from Blue Hill. The last is correct, if instruments recording graphically and continuously, such as are now generally used to obtain observations in the upper air, are meant. Andrée, on his ill-fated north-polar voyage, had two companions, Fränkel and Strindberg, and not three, as said on page 196. It can not be admitted that a projectile fired vertically would fall back with the velocity with which it left the gun, as is asserted on page 213. If dirigible balloons are unable to "tack," like sailing ships (page 226) this is equally true of flying machines. The species of wood suitable for constructing the latter which are named on page 269, have a foreign habitat and none equal the American spruce. In the index, John Wise, the old-time balloonist, is confounded with Lieutenant Wise, the modern kite-experimenter.

The aeronautical achievements are brought down to August, 1909, after Blériot's flight across the Channel had brought home to Englishmen the possibility of aerial invasion, which furnished the psychological moment for publishing this book. A. Lawrence Rotch

Blue Hill Meteorological Observatory

SCIENTIFIC JOURNALS AND ARTICLES

The March number (volume 16, number 6) of the *Bulletin of the American Mathematical Society* contains: Report of the annual meeting of the society, by F. N. Cole; Report of the winter meeting of the Chicago Section, by H. E. Slaught; Report of the meeting of the American Association, by G. A. Miller; "Shorter notices": Smith's Rara Arithmetica, by L. L. Jackson; Fine and Thompson's Coordinate Geometry, by E. B. Cowley; Boutroux's Fonctions definées par les Equations différentielles du premier Ordre, by C. L. E. Moore; Worms de Romilly's Premiers Principes des Sciences mathématiques, by J. B. Shaw; Auerbach's Taschenbuch für Mathematiker und Physiker, by J. B. Shaw; Laurent's Statistique mathématique, by H. L. Rietz; Duhem's Théorie physique de Platon à Galilée, by E. B. Wilson; Clark's Slide Rule, by F. Cajori; Annuaire du Bureau des Longitudes pour l'An 1910, by E. W. Brown. "Notes on the Institut de France and the annual meeting of the Académie des Sci-

ences," by R. C. Archibald; "Notes"; "New Publications."

The April number of the *Bulletin* contains: "Simon Newcomb," by E. W. Brown; "A new proof of Weierstrass's theorem concerning the factorization of a power series," by G. A. Bliss; "On some theorems in the Lie theory," by L. D. Ames; "On the discontinuous ζ-groups defined by rational normal curves in a space of n dimensions," by J. W. Young; "A new analytical expression for the number π, and some historical considerations," by G. Vacca; Review of Hermite's Works, Volume II., by James Pierpont; "Shorter notices": Serret-Scheffers, Differential- und Integralrechnung, third edition, Volume III., by A. R. Crathorne; Richter's Kreis und Kugel in senkrechter Projection, by D. D. Leib; Granville's Plane and Spherical Trigonometry, by Jacob Westlund; Lecornu's Dynamique appliquée and Boulanger's Hydraulique générale, by J. B. Shaw; Schafheitlin's Besselsche Funktionen, by A. R. Crathorne. Correction; "Notes"; and "New Publications."

REFLECTIONS ON JOLY'S METHOD OF DETERMINING THE OCEAN'S AGE

As is well known to all geologists, the very important method of estimating the age of the ocean devised by Mr. J. Joly consists substantially in dividing the total sodium content of the sea water by the yearly contribution from the land, this annual tribute being ascertained by analyzing river waters and gauging the streams. It is assumed on uniformitarian principles that what variation there has been in the annual salt tribute is undiscoverable.[1] In a long-forgotten memoir Edmund Halley[2] made a very similar suggestion and anticipated Lyell in propounding a strictly uniformitarian doctrine of the accumulation of salt.

Oceanic sodium is at least chiefly derived from lime-soda feldspars, which as essential constituents are practically confined to Archean and later igneous rocks. The original surface of the earth must have consisted of such rocks to the exclusion of all others, while at the present day the greater part of the land area is covered with sedimentaries. Now the rate of decomposition of rocks is chiefly dependent on exposure. Even in areas of ancient feldspathic massives decomposition does not seem to penetrate to great depths. Thus in the southern Appalachians great areas of gneiss and allied rocks are now covered by a blanket of saprolite (rotten rock in place) which is in many localities 50 feet in thickness, but at all the points where I have observed it less than 100 feet thick. Immediately below the saprolite blanket there is incipient decomposition and the feldspars are milky, but not many yards lower down the feldspars are characteristically translucent and the rock bluish in tint. A layer of decomposition products 100 feet thick seems to arrest decay. Corresponding statements are true of Tertiary volcanics excepting where the decomposition is solfataric. On the other hand Mesozoic and Paleozoic massive rocks deeply buried under sediments are not seldom found to be very free from decomposition. In short, buried massives decompose at a rate which is scarcely sensible.

It is quite conceivable that in the far distant future all the massive rocks might be thoroughly decomposed down to sea level or a trifle below. The continents would then be exclusively detrital. Under such conditions there could be no further important additions to the sodium content of the ocean, for there would then be no leaching, while mere diffusion to any considerable distance is too inordinately slow to produce any noteworthy result even in millions of years.

Thus in the distant past there must have been a time when a far greater mass of massive rock was decomposed each year than now decays in the same period; and a limit to this process can also be foreseen. The total area of exposed massives has surely diminished and will continue to diminish. Climate and temperature may perhaps have been in the past much what they are to-day; the rate of chem-

[1] *Trans. R. S. Dublin*, Vol. 7, 1899, p. 23, and Brit. Assoc. Rep., 1900, p. 369.

[2] Science, Vol. XXXI., March 25, 1910, p. 459, and *Phil. Trans.*, Vol. 29, 1715, p. 296.

ical denudation per unit area may not have changed considerably, but the most rigid uniformitarian would not maintain that the total area of exposed massive rocks has been constant. The inference seems unavoidable that sodium accumulation is an asymptotic process which progressed more rapidly (though possibly not with greater intensity) in the distant past and will come substantially to an end when a certain very finite layer of surface material has been exhausted. It seems worth while to attempt some rough estimates based on this conception of the saltness of the ocean.

There is a great deal of evidence for the elder Dana's generalization as to the permanence of continental areas. Dana would have been the last to assert absolute invariability of the land area but, just as it seems less hazardous to assume a uniform areal rate of decomposition than any uncertain or fanciful variation of that rate, so it seems safest for the present purpose to suppose the total area constant.

The simplest law compatible with the conditions set forth is that the proportionate decrease in the sodium-producing exposures of massive rocks has been constant. This is of course the familiar compound-interest law. In other words the hypothesis proposed is that the area of exposed sodium-bearing rocks can be represented approximately by the descending exponential which is so characteristic (in Mr. Walcott's words) of cases in which "an entity is subject to gradual extinction or absorption."

If A is the total constant land area and y the exposure of sodium-bearing rocks when the ocean had an age of t years while c is a certain constant to be determined from limiting conditions, then the hypothesis to be examined is

$$y = Ae^{-t/c} \quad \text{or} \quad t = c \log A/y.$$

Suppose the total sodium content of the ocean at time t to be N and let my be the increment of N in any one year. Then m being constant

$$N = \int_0^t my\,dt = Amc(1 - y/A).$$

Here N is pretty well known, and so is A, or at least its present value, while m and the value of y for the present time are known to a certain degree of approximation. Hence c can be found. If t were infinite, y would become zero, and therefore Amc represents the total sodium which can possibly be supplied to the ocean if the hypothesis fits the case. From this total it is easy to compute the thickness of the layer of average massive rock which would yield it.

Mr. Joly's assumption expressed in this notation is that, subject to minor corrections,[3] the age t would be given by N/my. His data are

$N = 14{,}694 \times 10^{12}$ and $my = 155.42 \times 10^{6}$ tonnes (or metric tons) and I shall adopt the same values in order to obtain strictly comparable results. The ratio N/my is 94.544×10^{6}.

A careful study of the areas of exposure of the principal geological formations was made by the late distinguished physical geographer Lieutenant-General Alexis von Tillo. This includes the Archean and the younger eruptives, the results being expressed in hundredths of the total surveyed area. The following is an extract from von Tillo's table.[4]

Continent	Archean	Eruptives	Total
Europe	20.6	1.3	21.9
Asia	17.7	4.7	22.4
Africa	18.4	2.2	20.6
Oceanica	20.0	4.8	24.8
North America	27.2	5.5	32.7
South America	18.7	4.6	23.3
Mean	20.3	4.0	24.3

The most recent geological map of North America (compiled by Mr. Bailey Willis) shows that the relative area of exposed feldspathic rocks on this continent is not so large as was supposed when von Tillo wrote, and, though I have made no minute measurements, this exposure as now mapped seems not to exceed 25 per cent. With this emendation von Tillo's table shows a truly remarkable uni-

[3] Especially for marine denudation and uncertainty in the volume of the ocean.

[4] *Comptes Rendus*, Paris, Vol. 114, 1892, pp. 246, 967.

formity throughout the world, all the figures lying between a fourth and a fifth of the total area. He too was impressed by the smallness of the variation in the relative areas of Archean exposures.

It seems well established that at the present day the relative area of y/A lies between two tenths and three tenths. The values for the constant c, the ultimate sodium accumulation, Amc, and the present age, t, as computed from the formula are given in the following table for these extremes and also for $y/A = 1/4$.

y/A	0.20	0.25	0.30
c	23.636×10^6	31.515×10^6	40.519×10^6
Amc	$N\ 5/4$	$N\ 4/3$	$N\ 10/7$
t	38.0×10^6	43.7×10^6	48.8×10^6

It can also be computed from the formulas at what rate the area of massive rocks is diminishing. This is expressed by $dy/dt = -y/c$. Substituting for y its value in terms of A and taking A at 134.38×10^6 square kilometers gives the mean annual net decrement for each of the three cases at almost exactly one square kilometer in spite of additions due to vulcanism, a result which is certainly not startling.

Mr. F. W. Clarke[8] has shown that a shell of average igneous rock enveloping the globe and 2,225 feet (678.2 meters) thick would furnish all the salt of the ocean. The ultimate thickness of the decomposed shells corresponding to the three values of y/A would be proportional to Amc, that is, 848, 904 and 969 meters, respectively, so that Clarke's shell would never assume improbable dimensions, or exceed three fifths of a mile.

Much the weakest point in this speculation seems to me to be the assumed constancy of the land area. This has assuredly fluctuated, yet when shallow seas flooded portions of the continents, marine denudation took the place of erosion in part, at least, and was possibly an equivalent. A is taken as constant only because there seems no way at present in which its variations can be rationally represented. The present marine denudation is offset to some extent by wind-borne or cyclic salt. It seems to me needless to consider the sodium content of sedimentaries as a source of supply for the ocean. Limestones contain a mere trace of sodium. Shales—which are the prevalent detrital rocks—(including clay, clay-slate and phyllite) contain sodium, but seemingly in a stable form, since ancient phyllites and modern clays are indistinguishable by their sodium content. Sandstones do not contain enough sodium to affect the problem of the earth's age, considering the greater uncertainties. Possibly some massives underlying thin layers of sedimentaries yield a little sodium, but, per contra, areas properly mapped as Archean or massive are in many localities protected by saprolite. This is true locally even in glaciated Alaska. Considering such protection, I believe the effective value of y/A to be nearer a fifth than a quarter.

Possibly it may be worth while to refer to the evident fact that if the descending exponential properly represents the history of the accumulation of sodium in the ocean, this became highly saline much earlier than on Mr. Joly's theory. Thus when the earth was half its present age the law of linear increment would of course imply that there was half as much salt in the ocean as there is now, while if the exponential relation holds good and $y = A/5$, the ocean at that epoch contained seven tenths of the present amount. The fauna of the Paleozoic indicates a salt-water habitat. If the deep was then as briny as it now is, it must have taken in a vast amount of juvenile water in the mean time on either hypothesis.

The annual increment of N or the quantity here called my is susceptible of improved determination, as every one has recognized. Mr. Clarke is now engaged on a discussion of this subject based on far more extensive material than was at Mr. Joly's disposal, and his results will be available in a few months. When they are known, it will take only a few minutes to recompute the age of the earth on the hypothesis here discussed.

The foregoing speculation is based on the assumption that the area of sodiferous rocks has diminished by a constant proportion ($1/c$)

[8] "Data of Geochemistry," 1908, p. 28.

per unit of time—about a thirty-millionth part each year. This can not be precisely true, but I think it must be a better approximation than the hypothesis that this area has undergone no diminution at all. The results may err in either direction. Thus the rate of diminution may fluctuate; if it is now above the average the exponential relation would give too low a value for the earth's age, and *vice versa*. Whether the rate is actually above or below the average we have no means of discovering. Again it is wholly improbable that either intensity of decomposition or the average yield of sodium per square kilometer of sodiferous rocks has always been the same, and this yield may now exceed the mean or fall short of it.

It appears that Mr. Joly's linear relation between oceanic sodium and its increment must lead to an excessive estimate of the earth's age, at least when the increment is duly determined. Thus that method assigns a limit, a knowledge of which is very valuable as a check on other computations. On the other hand, the ages computed from his data by the exponential expression seem to me suspiciously low. Various trains of reasoning lead me, at least, to believe that 50 million years is not a maximum but a minimum age; if so and if the exponential hypothesis is applicable then Mr. Joly's datum for the annual sodium increment is too large.

GEORGE F. BECKER

WASHINGTON, D. C.,
February 26, 1910

BOTANICAL NOTES

RECENT STUDIES OF THE FUNGI

DR. J. J. DAVIS'S "Fourth Supplementary List of Parasitic Fungi of Wisconsin" in the *Transactions of the Wisconsin Academy of Sciences, Arts and Letters* adds many new hosts, many species not hitherto reported, and some species new to science. All of the latter are Fungi Imperfecti. With this may be noticed the same author's "Mycological Narrative of a Brief Journey through the Pacific Northwest" (in the same *Transactions*) in which we are reminded of the itineraries of the earlier botanists, like Kalm and Pursch, or even the master traveling botanist, Linné, in which not only are we told of the plants observed and collected, but we are made delightfully aware of the botanist himself. Our younger botanists might profitably study the style of the paper before us.

In these days when all lichens are fungi, we may notice here L. W. Riddle's "Key to the Species and Principal Varieties of Cladonia occurring in New England," which appeared in *Rhodora* for November, 1909. It looks promising, and no doubt will be helpful to students.

Of quite a different nature is Professor Atkinson's paper on "Some Problems in the Evolution of the Lower Fungi," published in *Annales Mycologici*, 1909. It was first delivered as the presidential address before the Botanical Society of America. In a most ingenious manner the author argues for the origin of the Phycomycetes from the lower unicellular algae such as the Protococcoideae through Chytridiales, to Saprolegniales, etc. He discusses the "degenerative influence of parasitism" and comes to the conclusion that "there seems little in support of the theory." On the contrary, he builds up "a natural series from Chytridiales to the Oomycetes and Zygomycetes, showing progressive evolution of the vegetable body and sexual process." While the paper may not be conclusive, it is suggestive and should be read by every student of the lower fungi.

W. H. Brown, in a note on "Nuclear Phenomena in *Pyronema confluens*" in the Johns Hopkins University Circular, 1909, points out that "it seems probable that the fusion of the sexual nuclei originally took place in the ascogonium, but later was delayed until some point in the development of the ascogenous hyphae." In this way he suggests a reason for the disappearance of the functional sexual organs in many fungi.

Here may be mentioned several papers on the economic aspects of certain parasitic fungi; namely, H. T. Güssow's "Serious Potato Disease occurring in Newfoundland" (Bull. 63, Canadian Dept. Agric.), in which a

species of *Chrysophlyctis* is shown to be the cause of a canker of the tubers which has been very destructive in Europe and has now appeared in Newfoundland. It produces rough nodules which emerge from the "eyes" and enlarge and spread over the surface of the tubers. So too the botanist will find much of interest in R. E. Smith's "Report of the Plant Pathologist" in Bull. 203 of the California Experiment Station, including as it does discussions of pear blight, walnut blight, apricot diseases, brown rot, etc., with a list of plant diseases additional to those previously reported. One of the most useful of recent papers on plant diseases is Professor Heald's "Symptoms of Disease in Plants" in Bull. 135 of the University of Texas. While ostensibly addressed to "persons engaged in general farming," it will prove to be one of the most useful introductions to plant pathology available for the young botanist. Here in an orderly sequence the principal aspects of plant diseases are brought before the reader in a lucid text aided by excellent photographs which have been well reproduced in "half-tones." If the author would make an index to this paper, and have it cheaply bound it would be an excellent little book (of about 65 pages) for use in the classes in agriculture in the high schools.

NOMENCLATURE OF THE FUNGI

A year ago twenty-six prominent American students of the fungi formulated "Motions for Additional Articles Relating to the Nomenclature of the Fungi to be presented at the International Botanical Congress at Brussels in May of the present year." The motions advocate (A) beginning mycological nomenclature with the "Systema Mycologicum" of Fries, 1821–1832; (B) the interpretation of the Friesian "tribes" of *Agaricus* as genera in the modern sense; (C) the making of a list of *genera fungorum conservanda,* in spite of the law of priority; (D) the application of the present rules as to generic names of monomorphic fungi; (E) the recognition and retention of the generic names of the "perfect form" of the pleomorphic fungi; (F) the application of the present rules as to specific names of monomorphic fungi; (G) the recognition and retention of the specific names of the "perfect form" of the pleomorphic fungi, with certain modifying provisions. It is further "recommended" that authors add figures to their diagnoses; that they conform to Recommendations VIII.–XIV. of the Vienna Code; that they indicate type species in genera.

Quite recently there has come to hand a paper by Professor W. G. Farlow, entitled "A Consideration of the Species Plantarum of Linnaeus as a Basis for the Starting Point of the Nomenclature of Cryptogams," which shows conclusively the inadvisability of using the Linnaean work, for the fungi at any rate. While he does not pronounce definitely upon the matter, he shows some very good reasons for preferring the "Systema Mycologicum" of Fries. In passing he throws the weight of his authority in favor of a list of *genera conservanda,* saying "there is nothing illogical in this, and practically there are great advantages."

From the foregoing it may be fairly predicted what will be the outcome of the Brussels Congress, and for the most part it seems good to the present writer, who, while not daring to hope for a perfectly satisfactory code, is ready to accept the best that can be made now, while still hoping for its betterment in future congresses.

DESCRIPTIVE BOTANY OF THE FLOWERING PLANTS

Dr. Millspaugh continues in Publication 136 of the Field Columbian Museum his "Praenuciae Bahamenses," this being No. II., and including a map of the Bahaman Archipelago, a list of the collectors, observations and descriptions of new species (the latter in Latin!), a list of native plant names, and an index to I. and II. From the index we learn that in the two parts three new genera and fifty-three new species or new combinations have been described.

J. N. Rose and J. A. Purpus describe "Three New Species of *Echeveria* from Southern Mexico" in the Contributions from

the U. S. National Herbarium (Vol. 13, pt. 2) illustrating the paper by five fine photographs.

Professor Aven Nelson's "Contributions from the Rocky Mountain Herbarium," VIII. (*Bot. Gaz.*, XLVII.), includes many new species from the deserts of southern Nevada and adjacent Arizona, collected by L. N. Goodding in 1905.

Dr. E. L. Greene has taken time enough from his historical studies to bring out a number of descriptive or critical papers, among which are "New Californian Asteraceae," "Some Western Caulescent Violets," "Two New Southern Violets," etc., in his Leaflets of Botanical Observation and Criticism (Vol. II.); and "Some Thalictra from North Dakota" in the *Midland Naturalist* (October, 1909). Three new species are described.

Professor W. L. Jepson's "Synopsis of the North American Godetias" (University of California Publications, Vol. 2, No. 16) is a careful and exhaustive study of the species of this Pacific coast genus. Seventeen species are recognized, of which six are new. A helpful plate accompanies the paper.

Another paper on cactuses—"Cactaceae of Northeastern and Central Mexico," by W. E. Safford (Smithsonian Report for 1908), adds materially to our knowledge of these interesting plants. The first twenty pages are devoted to a general discussion of the structure, morphology and classification of the cactuses at large, while the remaining eighteen pages are given to a synopsis of Mexican Cactaceae. Fifteen fine plates and twenty-four text figures make this a valuable paper for any one who wishes to learn about the Cactaceae.

Here we may briefly mention Professor Schaffner's "Pteridophytes of Ohio," which is in reality an excellent local manual of these plants; Professor Shimek's "Flora of Winneshiek County" (Iowa), being a useful annotated list, with ecological discussions; Professor L. H. Harvey's "Floristic Composition of the Vascular Flora of Mount Ktaadn, Maine," with analytic tables and discussions; and lastly Professor Ruth Marshall's "Vegetation of Twin Island" giving the results of several summers' studies of a small island in Lake Spooner in northwestern Wisconsin. It contains a suggestion as to what may be accomplished scientifically while having a good outing.

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SPECIAL ARTICLES

THE SEX-DETERMINING CHROMOSOMES IN ASCARIS

IN 1908 Professor Boveri observed in an especially large number of the fertilized eggs of *Ascaris megalocephala bivalens*, a small chromatin element which he had already previously seen, and thinking that it might be a sex chromosome, he suggested to Miss Boring that she should make an exact study of the chromatin conditions in this species. Though Miss Boring obtained important results,[1] she could not arrive at any positive conclusion concerning the significance of this element. In an appendix to Miss Boring's paper (*l. c.*), Professor Boveri concludes that this small chromosome in *Ascaris megalocephala* is a sex-determinant, and also reports the finding by himself and Gulick, of a heterochromosome in *Heterakis*, which behaves exactly like the heterochromosome in some hemiptera (type *Protenor*, of Wilson).

Following the suggestion of Professor Boveri, I have worked upon the spermatogenesis of *Ascaris megalocephala* and *Ascaris lumbricoides*. In the maturation divisions of the spermatogenesis of *Ascaris megalocephala*, which have been very accurately investigated by O. Hertwig and Braur, and also by Miss Boring, nothing has been observed hitherto of an independent chromatin element that could be interpreted as a heterochromosome. Boveri (*l. c.*) has offered as an explanation for this condition, that the heterochromosome here may be united with one of the large chromosomes. Studying a great number of males of *Ascaris megalocephala*, I have found one in which an independent heterochromosome can be followed throughout the whole maturation period and another in which it is present in

[1] *Archiv f. Zellforschung*, V. 4.

the primary spermatocytes. The heterochromosome in the vesicular nucleus of the primary spermatocytes is a small element composed of two halves lying to one side of the two tetrads. In the first maturation division the two halves of the heterochromosome are distributed to the two daughter cells and in the second maturation division, the now simple heterochromosome passes over undivided to one spermatid. So one half of the spermatozoa contain the well-known two rod-formed elements, while the remaining spermatozoa possess in addition to the two large chromosomes, the small heterochromosome. There can be scarcely any doubt that this element is identical with the "small chromosome" described by Miss Boring for a part of the fertilized eggs.

In *Ascaris lumbricoides* I have found the sex-determinant in the form of a group of five univalent chromosomes passing undivided to one daughter cell in the first maturation division so that one half of the secondary spermatocytes, and consequently one half of the spermatozoa, have 19, the other half, 24, chromosomes. This type has some similarity with that of *Gelastocoris* described by Payne,[2] but differs from it in this respect that in *Ascaris lumbricoides* all five constituents of the group go to one daughter-cell.

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[2] *Biol. Bull.*, V. 14, 1908.

THE AMERICAN FEDERATION OF THE TEACHERS OF THE MATHEMATICAL AND NATURAL SCIENCES

The annual meeting of the council of the American Federation was held on Monday, December 27, 1909, at the Massachusetts Institute of Technology in Boston, Mass. There were twenty-two representatives of eight associations present. The report of the executive committee showed that six associations had joined the federation during the past year. The total number of paid-up members in the associations that belong to the federation now amounts to 2,040.

Reports were presented from the local associations showing activity and progressive work in all.

The committee on bibliography of science teaching reported that its work was completed and urged the federation to get the bibliography printed as soon as possible.

The committee on a syllabus in geometry reported that work was well under way. The committee has been divided into three sub-committees, one on logical considerations, one on lists of basal theorems and one on exercises and applications. The committee expects to have its work completed during the coming year.

The committee on college entrance requirements had gathered a large amount of information which showed the great variation in the requirements of the different colleges and showed that it was impossible for any school to meet them all. The committee recommended that the federation take up this matter with the College Entrance Examination Board and see what can be done toward bringing about uniformity. The report was accepted as a report of progress and the committee continued and urged to carry on the work.

The committee on publication recommended that the federation publish its reports in *School Science and Mathematics* and such other journals as would accept them and urged that the local associations send their reports of their meetings to *School Science and Mathematics* promptly and regularly. The report was accepted as a report of progress and the committee continued.

The New England Association of Chemistry Teachers presented a request that the federation appoint a committee to make suggestions for changes in the definition of the requirement in chemistry and that the federation should bring this matter to the attention of the College Entrance Examination Board. The request was approved.

A letter from the College Entrance Examination Board asked cooperation of the federation in determining what form of logarithm tables were best to study for examination purposes. It was voted that a committee be appointed by the chair in accordance with the wishes of the college board.

The question of the publication of a journal for mathematics alone was discussed at some length and it was voted that a committee be appointed to consider this question and report at the next meeting.

Informal reports of progress were presented by members of the International Commission on Teaching of Mathematics.

The nominating committee reported nominations

for the coming year, and these officers were unanimously elected:

President—C. R. Mann, University of Chicago.

Secretary-Treasurer—Eugene R. Smith, Brooklyn Polytechnic Institute.

Members of the Executive Committee—J. T. Rorer, William Penn High School, Philadelphia; W. Segerblom, Phillips Exeter Academy; I. N. Mitchell, State Normal School, Milwaukee, Wis.

Professor C. H. Judd, of the University of Chicago, addressed the federation on the topic, "Scientific Experimental Investigation of Education." The speaker indicated that opinions concerning education were usually based upon rather vague and uncertain data. He urged that problems in education were capable of solution by scientific experiment and that they should be solved in that way. Several experiments were presented as types which might be followed.

Mr. H. R. Linville, of Jamaica, N. Y., presented an address on "Old and New Ideals in Biology."

The meeting adjourned subject to the call of the executive committee.

C. R. MANN,
Secretary

THE AMERICAN ASSOCIATION OF ECONOMIC ENTOMOLOGISTS

THE twenty-second annual meeting of the American Association of Economic Entomologists was held at the Harvard Medical School (Brookline), Boston, Mass., December 28 and 29, 1909. The first session was called to order by President W. E. Britton, of New Haven, Conn., who presided throughout the meeting, and who delivered the annual address on "The Official Entomologist and the Farmer." The program was crowded with papers which were of great economic importance to the entomologist and the agriculturist, although a few were more technical in character and dealt with some of the fundamental principles of scientific investigation of entomological matters. A discussion of different methods used in research work was of particular interest, as were also the reports of the progress that is being made in the field and parasite work in New England for the purpose of controlling the gypsy and brown-tail moths. A report by Dr. W. P. Headden, of Colorado, concerning the injury to fruit trees caused by arsenical spraying and the discussions that followed brought out many new ideas on this important subject. An exhibit made by the local entomologists and members which was held in an adjoining room contained samples of apparatus and breeding devices, as well as insect collections, which added much interest to the meeting. On Tuesday evening the association and the Entomological Society of America were the guests of the Cambridge Entomological Club and on Thursday morning the members had the opportunity of witnessing a spraying demonstration at Arlington with high power sprayers, as the guests of Mr. H. L. Frost.

The attendance at each session numbered over 100 members and visitors, nearly every section of the United States and Canada being represented.

The association commended the work which is being done to control the gypsy and brown-tail moths in New England, endorsed the bill before Congress to provide for the establishment of standards of purity of insecticides and fungicides and advocated the passage by Congress of a national law to prevent the importation of dangerously injurious insects and fungus diseases from foreign countries.

The report of the secretary showed that the association was increasing in membership and was in good financial condition. The *Journal of Economic Entomology*, which is the official organ of the association, was also reported by the business manager to be in a thriving condition.

The following officers were elected for the ensuing year:

President—Professor E. D. Sanderson, Durham, N. H.

First Vice-president—Dr. H. T. Fernald, Amherst, Mass.

Second Vice-president—Professor P. J. Parrott, Geneva, N. Y.

Secretary—A. F. Burgess, Washington, D. C.

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 226th meeting of the society, held at the George Washington University on Wednesday, January 26, 1910, Mr. Edson S. Bastin informally exhibited specimens of pegmatites whose quartzes had been tested by Messrs. Wright and Larsen.

Regular Program

Some Pegmatites from Southern California: W. T. SCHALLER.

The pegmatites of Southern California which have been exploited for their valuable gem minerals (tourmaline, spodumene, etc.) are granitic rock bodies filling fissures in gabbro. Many of these bodies consist of two parts of approximately equal thickness—namely, an upper coarse granite and a lower fine-grained banded garnet aplite.

The lithium and gem minerals occur in the bottom of the upper part and consequently near the center of the entire body. A number of distinct structural varieties of pegmatite may be recognized, all formed by vein processes.

The Cobalt Mining District of Ontario: MR. S. F. EMMONS.

The features of the Cobalt silver deposits that most strikingly differentiate them from those of most mining districts are:

Mineralogically, the predominance of the metals cobalt, nickel, silver and bismuth, with an almost total absence of lead and zinc, and their prevalent combination with arsenic and antimony rather than with sulphur.

Structurally, the extreme narrowness of all the rock fractures, and the general absence of evidence of any considerable displacement such as is afforded by slickensides or clay selvages. Nevertheless, very decided proof exists that the veins are true fault fractures, not contraction cracks, in that they contain dragged-in fragments of wall rock, that they pass uninterruptedly from one rock formation to another, even though separated by a great unconformity, and that in the coarse so-called conglomerate, in which they were first discovered, they cut through matrix and included fragments indifferently. They seem to be fractures that have been produced under so great a load of overlying rocks that movement had been greatly restricted.

Genetically, the predominance of silver in the metallic state over its combinations with sulphur, arsenic and antimony; and the remarkably abrupt falling off in the tenor of this metal from the bonanza zone, where it is measured by thousands of ounces per ton, to the ordinary low-grade cobalt vein with less than ten ounces, a change that takes place within very few feet.

These facts seem best explained on the assumption that the present veins are only the roots of veins that were originally of great vertical extent but have been mostly worn away; and that these remaining vein roots have been gradually enriched by successive leachings-back for unusually long geological periods (for both primary and secondary vein fractures are of pre-Cambrian age).

The secondary fractures within the veins that carry the most of the silver are probably not the channels through which the silver was originally introduced, but simply those which, by the admission of solutions leached down from the surface, have produced an extraordinary enrichment in this metal.

The conclusion seems warranted, therefore, that the rich silver veins are not, as was originally assumed, confined to any particular formation, and that while the bonanza portion of individual veins has a limited extent in depth, the abundance of small fractures or calcite veins, that may at any time pass into bonanza, renders the future of the district very promising.

The Mechanical Part of a Paleontologic Monograph: LANCASTER D. BURLING.

The value of a monograph depends so largely upon the accessibility of the material which it contains that current methods are believed to be inadequate for the proper presentation of the results of careful research. Some improvement in the monographic treatment of paleontologic subjects may be accomplished by the introduction of the following features. They should be regarded as merely an initial step in what is believed should be a general attempt to raise the standard of monographic methods.

1. A list giving the present reference of every generic or specific name occurring in the synonymy, arranged alphabetically by specific as well as generic and subgeneric terms.

2. Detailed localities with locality numbers (original where possible or arbitrary where taken from the literature) and a list of the localities giving them in detail (with reference to published sections if possible) and citing the included species.

3. Sections typical of each general area or province covered by the monograph, giving in one column the species occurring in the section and in a second the species occurring elsewhere throughout the larger area in their approximate stratigraphic position; tables, arranged by faunal provinces, showing at a glance the species occurring in the major subdivisions of each; and summary tables showing the general geographic and stratigraphic distribution of the species, the genera and the families, respectively.

4. Descriptive notes indicating the source from which all or any part of each reference in the synonymy may have been copied, or the place in which any part of it may be duplicated, etc., and supplementary foot-notes under each genus giving a chronologic list (with references) of the various genera to which the species now placed in the genus have been referred.

5. Complete descriptions of plates naming the type specimens, giving the locality and catalogue numbers, and outlining a complete history of each previously figured specimen.

6. A separate bibliography, list of localities and index appropriate to the volume of plates when a separate volume is necessary, both indexes being arranged under the specific as well as the generic names.

EDSON S. BASTIN,
Secretary

AT the 227th meeting of the society, held at the George Washington University on Wednesday, February 9, 1910, under informal communications, Mr. David White exhibited several lantern slides prepared by the Lumière Company, showing in their natural colors the organic remains found in coals. The sections used for this trial were about seven microns in thickness and embraced cannel coals from Lesley, Ky., and Calloway County, Mo., and a brown xyloid lignite from Lehigh, N. D.

Mr. François E. Matthes described the site of an extinct waterfall in the Yosemite Valley, still conspicuous in the configuration of its north wall. The waterfall was existent only during glacial times, when the glacier in the hanging valley of Yosemite Creek sent a lobe up into the basin now known as the Eagle Peak Meadows. From the front of this lobe several streams coursed toward the canyon rim, converging near the edge and plunging over in several places but a few hundred feet apart. The cliff below receded under the action of the falls, and a marked horseshoe-shaped reentrant resulted. It is over the débris at the foot of the fall site that the lower zigzags of the Yosemite Falls trail are laid.

Regular Program

Coal-mining and Coke-making at Dawson, New Mexico: Mr. E. W. PARKER.

The plant of the Stag Canyon Fuel Company, which represents one of the highest types of coal-mining development in the United States, is located at Dawson, Colfax County, N. M., in Ts. 28 and 29 N., R. 20 E., and T. 28 N., R. 21 E. The coal property embraces part of the Raton Mountain region, and includes operations in and about Trinidad, Col., and Raton, Koehler, Van Houten and Dawson, N. M. There are two workable beds in the field, only one of which is being mined at the present time. The Dawson mines are on the lower of the two workable seams, known as the Raton or Blossburg bed. It lies nearly level and varies from 6 to 11 feet thick, with an average of about 7 feet.

The mining company is a subsidiary organization of the Phelps-Dodge interests, of Philadelphia, and the idealistic character of the plant is due to the beneficent influence of Dr. James Douglas, the president of the company, and to the administrative genius of Mr. E. L. Carpenter, its general manager.

The mining methods of the company, and the arrangements for handling the coal and preparing it for the coke ovens, are strictly modern throughout. Instead of the ordinary bee-hive coke ovens, modified underflue ovens are employed by which the gases from the coking operations are used for heating the ovens and also for generating the power used in the operation of the mines, the heating of the office, and other company-buildings, and for furnishing electric light to the town. Not a pound of coal is used in the power plant, which is a model of neatness and efficiency. Special provisions are made for the safety of the miners and other employees, and no shot-firing is done while any of the miners are within the mines. Careful supervision is exercised over the methods of undercutting and shearing coal and of placing shots, in order to avoid any possibility of windy or blown-out shots. A checking system is employed by which it is known that all employees are out of the mines before the shot-firers enter. The shot-firers make the electric connections, and after they have left the mines, the entrances are closed by iron gates and a red light is exposed in front of each gate in order to warn persons away and thus avoid accidents from flying débris, in case an explosion should occur.

The Stag Canyon Company further trains its men in first-aid-to-the-injured work; conducts a rescue station in which men are instructed in the handling of rescue apparatus, and a hospital service, provided for the employees at a minimum expense.

The Distribution of Platinum in the United States: Mr. DAVID T. DAY.

While recent high prices have caused active search for platinum, showing it to be rather widely distributed in many rocks, useful accumulations in the United States are at present limited to the Rambler mine, in southern Wyoming, and the Key West group of mines in Bunkerville, near eastern Nevada, and to about seven important groups of accumulations in connection with placer mines of the Pacific Slope. Most platinum was produced last year from the neighborhood of Oroville, Cal., where it occurs about in the proportion of 1 to 500 of gold. The proportion has not been determined for Trinity County, Cal., and Josephine County, Ore., the other two inland

localities. On the coast, platinum is found in the proportion of 2 to 1 of gold, near Surf, Santa Barbara County, but other places in the same region, including San Luis Obispo, show only 1 to 20 or 1 to 50 of gold.

The next important group of accumulations is found near Trinidad Head, Humboldt County, Cal., another at Crescent City, Cal., at the mouth of Smith River, Ore., and one on the South Fork of Smith River. The most important group of all extends from the mouth of Rogue River north to Coquille River. At Cape Blanco an accumulation of platinum has been found where that metal is five times as abundant as the gold. On the west coast of Washington platinum is comparatively abundant in the proportion of 1 to 10 and 1 to 15 of gold.

The Half Dome of the Yosemite Valley: MR. FRANÇOIS E. MATTHES.

The Half Dome, like the other domes of the Yosemite region, represents a huge granite monolith that has survived the reduction of the more fissile rocks about it by virtue of the superior resistance to disintegration of its undivided mass. It is unique in that its dome form is a partial or incomplete one, being abruptly trenched on the northwest by a straight and sheer cliff face 2,000 feet in height. The curving back and sides are entirely normal, having evidently evolved through progressive exfoliation, like the bulbous exteriors of all domes. Their smooth, sweeping curves are indicative of maturity; for it is only through long-continued shelling that a monolith of irregular shape is reduced to a continuously rounded mass. At the same time, the prevailing flatness of the back and its trend, parallel with the northeast-southwest system of joints, prominent throughout the region, are clearly inherited from the structure planes that originally bounded the monolith on that side.

For the origin of the sheer front of the dome, three alternative hypotheses have been advanced:

1. The present mass is a true half dome—that is, a remnant of a much larger monolith, the other portion of which has caved off, perhaps owing to glacial undercutting in the Tenaya trough.

2. The monolith extended originally but little farther to the northwest, and has suffered reduction on that side, as on the other sides, merely through normal exfoliation. Only, the shells on the northwest side were plane instead of curved, because the initial bounding surface was plane.

3. The present front coincides essentially with the plane fissure that from the first constituted the boundary of the monolith, and has only comparatively recently been exposed through the rapid scaling off of the thin plates of a zone of vertically sheeted rock.

The first hypothesis seems inadmissible, inasmuch as massive granites inherently break off by conchoidal fractures and not by plane fractures of the magnitude of the dome front. The second hypothesis finds some support in the overhanging shells on the top of the dome, for these plainly indicate the former extension of the monolith for a short distance to the northwest. The existence, however, of a great mass of plates clinging to the northeast end of the cliff face in the form of a conspicuous shoulder, together with the strongly accentuated fracture that separates them from the body of the monolith proper, is held to demonstrate conclusively that the monolith never did extend beyond its present front, but was actually bounded there by a zone of thinly sheeted rock. Only toward the top of the front has exfoliation set in and commenced its rounding off process (under the overhang), as is patent from the profile view of the dome obtained from the Quarter Domes. FRANÇOIS E. MATTHES,

Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 467th regular meeting of the society was held March 5, 1910, in the west hall of George Washington University, President T. S. Palmer in the chair.

The following communications were presented:

Remarks on a Restoration of Basilosaurus cetoides: J. W. GIDLEY.

Remains of this species were first discovered in Alabama in 1834 and Harlan applied to it its present generic name. Owen, in 1839, recognized its mammalian character and renamed it *Zeuglodon.* The present restoration is based on portions of two individuals, one of which furnishes the anterior and the other the posterior part of the animal. The restoration is almost complete. This mammal is somewhat distantly related to the whales. It has a total length of about 35 feet and a skull 5 feet long.

The Stridulations of some Katydids: H. A. ALLARD. (Read by the recording secretary.)

The author studied the stridulations of several members of the Locustidæ at Thompson's Mills, Ga., and at Plummer's Island, on the Potomac, above Washington City. The peculiar noises made by the following species were studied:

Scudderia texensis, S. furcata, Amblycorypha oblongifolia, A. rotundifolia, A. uhleri, Microcentrum retinerve, M. rhombifolium and *Cyrtophyllus perspicillatus*. The last is the true katydid, and has harsher notes than any of the others named. Photographs were exhibited showing several of these species in the act of stridulation.

Japanese Goldfish: HUGH M. SMITH.

Dr. Smith exhibited water-color paintings of the ten varieties of goldfish now known and cultivated in Japan, and discussed some of the biological points connected with the goldfish and its culture. The goldfish is grown more extensively in Japan than elsewhere; and in no other country is any purely ornamental animal maintained by a larger proportion of the population. This fish has been a favorite subject for biological study in Japan; and being exceedingly plastic material it has yielded surprises to the biologist as well as the culturist.

The goldfish, like various other things now firmly established in Japan, came originally from China, the first known importation of the cultivated fish being in the year 1500. The original stock has been greatly improved by cultivation and crossing, and is now superior to any of the Chinese breeds. The goldfish was probably not indigenous to Japan and the wild, plain-colored form there found represents a reversion.

Attention was called to the views and theories of Ryder (1893): (1) that the Japanese varieties of goldfish are the most profoundly modified of any known domesticated animal organisms; (2) that the greatly enlarged fins are correlated with a degeneration of the muscular system through disuse, owing to the "continued restraint of the fish in small aquaria through many generations"; (3) that the feeble swimming powers have been "purposely cultivated by oriental fish fanciers," and the energy that would have gone into motion has reacted in the growth of fins; (4) that the enlarged caudal and other fins may serve as supplemental respiratory organs; and (5) that this hypertrophy has been "developed in physiological response to artificial conditions of respiration in the restricted and badly aerated tanks and aquaria in which the fish have been bred for centuries."

As the salient feature of goldfish culture in Japan has always been the perfect oxygenation of the water in the rearing ponds, the speaker held that any theories based on the assumption of lack of aeration are untenable.

The most remarkable morphological features of Japanese goldfish are the elimination of the dorsal fin and the development of paired caudal and anal fins in some varieties. The division of the caudal is not merely a splitting of the superficial soft parts, but represents an actual bilateral separation of the deep-seated bony elements from which the fin arises.

The first and the last of these communications were discussed by Dr. Theodore Gill, Dr. T. S. Palmer and others.

D. E. LANTZ,
Recording Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

THE sixth regular meeting of the session of 1909–10 was held at the Chemists' Club on March 11.

The following officers were elected for the session of 1910–11:

Chairman—Chas. Baskerville.

Vice-Chairman—Samuel A. Tucker.

Secretary and Treasurer—C. M. Joyce.

Executive Committee—Morris Loeb, G. W. Thompson, J. E. Crane and Arthur E. Hill.

The papers presented were as follows: Wm. C. Ferguson, "The Determination of Copper in Blister and Refined Copper"; Chas. Baskerville, "Scrubbing Device for Vacuum System in the Laboratory"; J. L. Sporer, "Rack for Holding Reagents in Bulk"; H. T. Beans, "A Constant Temperature Drying Oven and Gas Regulator"; S. H. Beard, "An Automatic Pipette"; C. T. G. Rogers, "Description of a Modified Pettersson and Palmquist Apparatus for the Determination of Carbon Dioxide."

C. M. JOYCE,
Secretary

THE CHEMICAL SOCIETY OF WASHINGTON

THE 197th meeting was held in the Public Library on Thursday evening, March 10. President Failyer presided, the attendance being 52. The annual smoker will be held on April 9. The committee on communications was authorized to confer with the committee of the Washington Academy of Science in preparing programs for joint meetings. Dr. W. D. Bigelow, who had general charge of the construction of the new bureau of chemistry building, presented the only paper of the evening, viz., "The Construction and Equipment of a Chemical Laboratory." The paper was illustrated with lantern slides.

J. A. LECLERC,
Secretary

SCIENCE

FRIDAY, APRIL 8, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE DEBT OF PHYSICS TO METAPHYSICS[1]

IF I venture to address this society upon a subject where I am very liable, perhaps even likely, to be misunderstood, please bear in mind that I do so only in the belief that it is a matter of no small importance for workers in any one science to realize fully the limitations as well as the powers of their own science. It is hardly necessary to add, that while I shall consider a phase of physics which has little to do with experiment, I am not for an instant unmindful of the fact that ours *is* an experimental science, and that all the really great achievements in physics have been wrought through, or have led up to, or have been completed by, experiment and observation. This remark is doubtless true even of the supreme work of Newton, Fresnel and Maxwell. Nor am I forgetful that in days gone by the normal development of sound physics has been much retarded by metaphysics.

Second to none in my admiration of the man who has contributed even a single experimental fact to either the foundation or superstructure of the edifice which we call modern physics, I invite your attention for a few moments to the debit side of the account as it stands between the physicist and metaphysician. This I do with no little trepidation, remembering how easily one may, even with the utmost good will, go astray in a strange field of thought. Metaphysics is a term employed with such a variety of meanings that I must, at the very outset, explain the one sense in which

[1] Presidential address before the American Physical Society in New York, March 5, 1910.

I am using it. I am *not* employing it to indicate "the sum of all knowledge" (Paulsen), or as a synonym for the "science of the absolute" (Hegel), but rather as a branch of philosophy which is, in a certain sense, supplementary to all the individual sciences of phenomena. The metaphysician here in mind is a gleaner after physics and psychology, using these two words in their wide meaning so as to cover practically the whole of modern science. He it is who orients the sciences among themselves, criticizes their foundations, their methods and even their conclusions, in so far as these conclusions depend upon pure logic. He it is who rounds out and corrects the individual sciences. It will thus be seen that metaphysics, with these limitations, does not differ widely from the modern usage of the word philosophy; for the metaphysics I have in mind has been aptly characterized as "the supreme science of order."[2] There are those, and I myself am one of this class, who prefer to use the word "epistemology" to describe a metaphysics of this type. It is certainly not the type of metaphysics which allowed Kant to define matter in terms of force.[3] And, in any event, I trust we shall all agree that we are not getting into what Maxwell called "the den of the metaphysician, strewed with the remains of former explorers, and abhorred by every man of science."

But we must be careful to remember that the metaphysician which Maxwell here has in mind is not an epistemologist, but a man of the Hegelian type. Helmholtz[4] boasted that he never lost an opportunity to impress upon his students the principle that "a metaphysical conclusion is either a false conclusion or a concealed experimental conclusion." How far removed the more genuine metaphysics of to-day is from that which held sway during the first half of the nineteenth century and which exasperated men of the type of Maxwell and Helmholtz, may be indicated by the following paragraph from Professor A. E. Taylor,[5] of Aberdeen, himself a distinguished metaphysician. He says:

> Just because of the absence from metaphysics itself of all empirical premises, it can be no business of the metaphysician to determine what the course of events will be or to prescribe to the sciences what methods and hypotheses they shall employ in the work of such determination. Within these sciences any and every hypothesis is sufficiently justified, whatever its nature, so long as it enables us more efficiently than any other to perform the actual task of calculation and prediction. And it was owing to neglect of this caution that the *Naturphilosophie* of the early nineteenth century speedily fell into a disrepute fully merited by its ignorant presumption. As regards the physical sciences, the metaphysician has indeed by this time probably learned his lesson.

It is hardly necessary to add that the type of metaphysics here exposed is not one to which physics owes anything whatever, and is not the one I have in mind during these remarks.

I. THE MECHANICAL POSTULATE

The father of the present Duke of Argyll rendered marked service to science in pointing out how wide-spread is the use of physical and natural law. But nowhere in his notable volume, the "Reign of Law," does he indicate what may be called the most fundamental fact connected with the discovery and employment of such law, namely, that the very existence of laws governing natural phenomena is a postu-

[2] Congress of Arts and Science, St. Louis, 1904, Vol. 1, p. 236.

[3] Hoeffding, "History of Modern Philosophy," Vol. 2, p. 69.

[4] Vorträge, "Das Denken in der Medicin," p. 34.

[5] Congress of Arts and Science, St. Louis, 1904, Vol. 1, p. 240.

late laid down, consciously or unconsciously, by the investigator. No one, except the later metaphysicians, has convinced us that however tangled the knot of physical facts which we are called upon to explain, the first thing we *assume* is that these phenomena are subject to law. We assume that we are studying a machine which behaves in a definite manner.

This assumption—which we may call the mechanical postulate—is not something to be discovered or verified by experiment, not something whose adoption stamps a man as a materialist, not something which sane men consider, in order to accept or refuse, but something which *all* men adopt as a laboratory convenience, one might better say, a laboratory essential.

Nor is the mechanical postulate one which is confined to physics; but is employed in all the sciences where men are attempting to bring order out of chaos. It is not, therefore, something to be charged up against one in the sense employed when modern physics is said to rob the world of all spontaneity and sentiment, or when science is said to be devoid of poetry. While we treat nature as a machine and while we adopt the mechanical hypothesis as a necessity of productive scholarship let us be very careful however not to allow ourselves to dogmatize to the extent of saying that a machine is all we have.

Is not the physicist under obligations to the philosopher for making this matter perfectly clear?

Apparent deviations from mechanical law lead to some of the most important biological problems. Animate and inanimate matter may appear, at first glance, to belong in two different categories; and so they undoubtedly do as regards many of the superficial phenomena. But conversation with some of the most productive scholars of our country in zoological and botanical lines has convinced me that they are practically all working on the assumption that biological phenomena are physical phenomena. These investigators assure us, moreover, that the introduction of an *enteliche* here and there, wherever convenient, would be sufficient to discourage all serious research on life problems. The same point of view is expressed by Münsterberg when, in his classification of knowledge, he places physics and biology together at the very bottom of the group called "physical sciences."

The hatching of an egg is apparently a different process from that of melting ice, although both are accomplished by the application of heat. But to assume anything else than that they are both mechanical processes is merely to erect a barrier which shall delay the discovery of truth. The study of cytology and artificial parthenogenesis have already gone so far that the discovery of a much more definite connection between life and mechanics would shock the world perhaps even less than did Wöhler's synthesis of urea in 1828.

UNIFORMITY POSTULATE

There is of late a very distinct change of feeling in regard to the principle of the Uniformity of Nature—a principle which was widely circulated, a generation ago, as an experimental fact but which is now properly regarded as another formulation of the mechanical postulate. But, thanks to the metaphysician, this principle is now, so far as I know, regarded by us all, neither as an axiom nor as an empirical fact, but as a fundamental hypothesis which we may call the "uniformity postulate."

This assumption is practically equivalent to considering matter, energy and electrifi-

cation to have no personal or individual traits which we need take into account. Without this postulate we should be unable to generalize our physical laws so as to include many new phenomena—phenomena unknown at the time of the formulation of the law. The tenacity with which the experimentalist holds to his assumption of a simple law is well illustrated by two papers read before the last meeting of this society: papers which illustrate how complex nature is becoming as research goes on. I refer to the work of Professor H. W. Morse and Professor E. B. Rosa on electrolysis. Each investigation dealt with slight deviations from one of Faraday's fundamental laws: and each investigation apparently assumed its truth: in any event assumed an equally simple law. Thousands of engineering results obtained each day in the week convince us that there are no accidents in history and allow us to believe that no postulate was ever better justified by its success.

The behavior of nature in this respect always reminds me of a remark, really a new formulation, once made by Professor Michelson in describing the labor of several years in locating and eliminating the errors in a certain steel rod upon which he was cutting an accurate screw. "I felt," he said, "as if matched in a game against an opponent: *but my antagonist always played fair.*"

II. ENERGY POSTULATE

Passing now to the consideration of energy, it is not yet three score years and ten, since Poggendorff and Magnus refused space, in the *Ann. d. Physik.*, to Helmholtz's little tract, "Die Erhaltung der Kraft," on the ground that it was too metaphysical. But thanks partly to the clear vision of Helmholtz, partly to the clever analysis of H. Poincaré, and largely to the experimental success of the principle, the time has now come, I believe, when we can say that the conservation of energy is so useful, *as a postulate,* that present-day science can not successfully accomplish its work without it. Experiment has been able to demonstrate it as a law only for particular cases and only approximately: but experiments have been so numerous and compelling, as to have created a new attitude of mind in the present generation, leading us to believe that everywhere in the physical universe there is *some* constant quantity, corresponding to a certain constant of integration, called "energy."

The most recent illustration of the manner in which the physicist assumes this constancy is, of course, the case of the steady heat production in radium. No sooner had Curie and Laborde made this remarkable discovery, in 1903, than men began, *not* to doubt the validity of the law of the conservation of energy, but to look about for the energy which was thus being transformed into heat. Accordingly Rutherford and Barnes succeeded, in the following year, in showing that 23 per cent. of this intra-atomic energy was due to radium itself, 32 per cent. to radium C and 45 per cent. to the emanation and radium A together. In saying that the time has come when the Law of the Conservation of Energy may properly be regarded as one of the presuppositions of physics, it is to be carefully noticed that this statement does not include the Law of the Dissipation of Energy.

III. CAUSAL POSTULATE

The infinite regress involved in the search after causes and the vanity of attempting to follow a series of causes to its end are, at least, as old as the Greeks.

The postulate which the philosopher here shows us to be one of our presuppositions is as follows: events in physical science depend upon a few antecedents, knowing which we may successfully predict the immediate consequence, and may safely disregard all other circumstances. The brevity of the sequence which really determines phenomena in physics is a matter of continual surprise—while the length and complexity of the sequence in the case of ordinary human actions is a matter of equal astonishment.

But it is very easy to forget what a powerful influence this postulate has at times exerted in almost all departments of science. Few physicists, and still fewer engineers, of the present seem to realize that some of the most fundamental conceptions of our science have been introduced directly through the adoption of this postulate.

Take, for instance, what is perhaps the central idea of modern dynamics—the idea of force—an idea which is older than either that of mass or of energy. When viewed in the light of the causal postulate, *i. e.*, in the light of history, the definition of force becomes a matter of the utmost simplicity and perfect clarity. From many other points of view it is one of the most complex and puzzling of physical quantities. Sir Oliver Lodge says:

> We are chiefly familiar, from our youth up, with two apparently simple things, *motion* and *force*. We have a direct sense for both of these things. We do not understand them in any deep way, probably do not understand them at all, but we are accustomed to them. Motion and force are our primary objects of experience and consciousness; and, in terms of them, all other less familiar occurrences may be stated and grasped.

To identify "force" in this manner with the "muscular sensation" of tension or pressure, which we feel when giving an accelerated motion to a body or when equilibrating by muscular effort the pull of the earth upon a body, seems to me dangerously near darkening counsel with words, and quite contrary to the spirit of the modern mathematician and physicist who are mending their fences at every possible point to keep out ideas which are not clear, sharp and definite.

The standard definition of the engineer, and, I fear, of not a few students of physics, is set forth by Professor William Kent in his article on the teaching of dynamics which appeared in SCIENCE[6] a few weeks ago, namely, "Force is defined as a pull or push, something that causes or tends to cause either motion or a change in the velocity or direction of motion."

Now considering both of these points of view, which I believe are widespread, every one is willing to admit at once the existence of certain elastic, and gravitational, and muscular, and electric, and cohesive, stresses which none of us understand: but the historical, or, if you please, the metaphysical, point of view would appear to be something like the following.

So far from our possessing any direct muscular sense of force, in the physical meaning of the word as distinguished from muscular tension, with which we are all familiar, the idea is one which was introduced by an Italian professor of mathematics, but a comparatively short time ago. How short may be illustrated by the following circumstances:

My grandmother, who lived in my own home for a number of years, was born on the banks of the Brandywine in 1789. She was therefore a contemporary as well as a neighbor of Benjamin Franklin. When Franklin was a printer's lad in London he had a promise from a friend that he should be taken to visit Sir Isaac Newton. Sir Isaac Newton was born within the same week in which Galileo died. Two human

[6] SCIENCE, Vol. 30, p. 919, 1909.

lives suffice therefore to bridge the gap between Galileo and our contemporaries. Back to Galileo is not therefore a far cry.

Recognizing the limitations of his science, and seeing that the search after causes was futile, Galileo adopted the causal postulate and prepared to confess his ignorance of gravitation, cohesion, muscular tension, and to say that, when we see a body changing its momentum, there is a "force" at work upon it. Following is the sentence, from his "Dialogues"[7] in which he introduces force as a synonym for any of these unknown influences which produce acceleration:

It does not appear to me worth while to investigate the *causes* of natural motion concerning which there are as many different opinions as there are different philosophers. Some refer them to an attraction towards the center; others assign them to repulsion between the small particles of a body, while still others would introduce a certain stress in the surrounding medium which closes in behind the falling body and drives it from one of its positions to another. Now all these fantasies, and others too, must be examined; but it is not really worth while. For all that is needful is to see just how one investigates the properties of accelerated motion and how these are defined, *without consideration of their cause*, in such a way that the momentum (of the body) increases uniformly from the initial condition of rest in simple proportionality to the time.

The paragraph which I have just quoted is, so far as I am able to learn, the earliest expression and definition of that central physical quantity which we now call "force." Observe first of all the modesty of the man; twice within this definition he inserts a distinct disavowal of any consideration of the cause of motion. So far is he in advance of our modern text-books, that he declines to define force as a "cause of motion" or a "tendency to produce motion," but says it is not even worth while to consider the question from that point of view.

How clear these same ideas were to Newton will be evident from the following two sentences from the first book of the "Principia." He says:

For I here design only to give a mathematical notion of those forces without considering their physical causes or seats.

And again:

Wherefore the reader is not to imagine that by those words I anywhere take upon me to define the kind or the manner of any action, the cause or the physical reason thereof.

Having thus abandoned all consideration of cause and having assigned ourselves the simpler task of describing the motions of bodies, we come back to the definition of Galileo and Newton, namely, the rate of change of momentum—as the one perfectly *correct*, *competent* and *complete* description of force.

It remains only to show that Galileo had a clear and modern conception of momentum. This is sufficiently evident from the following paragraph in the "Dialogues."[8] He says:

It is clear that an impulse is not a *simple* matter, seeing that it depends upon *two* important factors, namely, the weights (il peso) of the colliding bodies and their velocities.

And again on the same page he says

It is customary to say that the "momentum" of a light body is equal to the "momentum" of a heavy body when the velocity of the former bears to the velocity of the latter the inverse ratio of their weights.

If then I have correctly stated the facts of the case, force would appear to be a pure concept of the intellect: but a precious concept; one which is well understood, clear, definite, quantitative, and one whose extraordinary usefulness has made

[7] Ostwald's "Klassiker der Exakten Wissenschaften," No. 24, p. 15.

[8] Ostwald's "Klasiker der Exakten Wissenschaften," No. 25, p. 44.

it survive through the entire history of physics.

The paradoxy of this dominant idea of modern physics being a mere picture created by the human mind, disappears when we consider how the same method is employed in subjects other than physics.

In history, for example, we have important culminating events which we ascribe to "certain influences," while as a matter of fact the most that we actually know and observe in history is a series of *individual* acts, prompted, we suppose, by certain purposes.

The Franco-Prussian war came when the German Kaiser decided to send the telegram from Ems, when Prince Bismarck decided to publish certain parts of this telegram, when Von Moltke decided that the army was ready, when Napoleon III. decided to emulate the military career of his uncle, when the Congress of Vienna decided, in 1815, to give Prussia additional Rhenish territory, when in 868 the father of Lothar gave to his son the middle kingdom, the modern Lorraine, between France and Germany.

In practise we find it more convenient to say that "certain influences" had been at work for a full thousand years which culminated in the victory of Prussia over France. In physics, we give to the corresponding "influences" the name forces. That's the whole story! We *measure* these influences by the mass-acceleration of the body under consideration.

The extension which this idea of force has received in later times is known to us all. Huygens was the first to show that Galileo's fundamental variable, linear momentum, might change in two ways, namely, in direction and amount; and he gives us for the first time a method of computing the force when the momentum varies in direction only—a force which we now call "centrifugal." Later, in the case of rigid bodies the conception of "angular momentum" was introduced; its time variation we now call either "torque" or "precessional couple" according as the angular momentum varies in amount only or direction only.

This definition is identical in form and meaning with that of Galileo.

The essential step made by Lagrange, in his treatment of the simplest possible case, namely, a single particle, is to derive both the time variation of momentum and the rate of directional change of momentum, each by differentiation of a single function.

Momentum for him is the velocity-variation of kinetic energy, a quantity whose time-variation is the tangential force; and centrifugal force is the space-variation of kinetic energy: but each of these is still a time-variation of momentum, agreeing perfectly with Galileo's original definition.

The space-variation of *potential* energy is the measure of stress—or more properly a stress integral—which we do not understand—but which nevertheless can be evaluated in terms of force.

I shall detain you for only one more illustration.

Faraday had discovered a quantity—the "electrotonic state," he called it—electro-kinetic momentum, we call it—whose variations through any closed circuit, were always accompanied by an electric current in that circuit. Not knowing the cause of this current, physicists agreed to say that an "electromotive force" was at work whenever the electro-kinetic momentum changed, and to define this electromotive force as the time rate of change of electro-kinetic momentum (Neumann). Here again we have a generalized force introduced as a synonym for an unknown cause; exactly as was done by Galileo in the first instance.

Let us distinguish carefully between the observed facts of nature and those tempting pictures of the human mind which we only too easily create and are only too apt to worship.

Among the realities of mechanics are to be mentioned bodies in motion, liquids flowing, springs changing length; among the abstractions of the subject—helpful and needful abstractions—but abstractions nevertheless—are to be numbered the forces, velocities and accelerations of these bodies. Only by understanding these matters and by drawing a sharp line here shall we avoid Maxwell's "den of the metaphysician."

It is not infrequently that one finds a clever metaphysician in the orthodox man of empirical science; and I am free to confess myself unable to say whether the majority of the criticisms of the foundations of our science are due to the physicist or the philosopher; but in either case the critic speaks *as a metaphysician*. As an illustration consider the penetrating criticisms of the foundations of rational dynamics recently given by Mr. Norman Campbell,[9] who shows that the science of mechanics is so loaded with assumptions that the experimental verification of its laws is utterly hopeless.

IV. PRELIMINARY DISCUSSIONS

Fourthly, metaphysics has, I believe, rendered distinct service in giving us certain helpful preliminary discussions. Indeed, it is the history of many of the special sciences, such as psychology and sociology, that they were at one time departments of philosophy—but now, having shown themselves amenable to experiment or observation and subject to the "reign of law," are established as kingdoms of their own. The very notion of mechanical law is at least as old as Thales—600 B.C.—whose idea it was, in common with Anaximander, Anaximenes and Heraclitus, that the variety of things is due to "a single material cause, corporeal, endowed with qualities and capable of self-transformation."[10] Ridiculous and absurd as this sounds to us, it nevertheless contains the fundamental conception of mechanical law, and made it easier for later men to adopt more useful hypotheses.

The history of the atomic theory illustrates well the value of this contribution. The atom of Democritus—a purely metaphysical structure—differs in no essential respect from the modern atom up to the year 1738 when Daniel Bernoulli initiated the kinetic theory of gases.

The contention of Anaxagoras that all bodies are really continuous has also been of the utmost help: Poisson adopted it *in toto* in his mechanics; it was employed in electrical science up to the date of Helmholtz's Faraday lecture, 1881, and it is to-day practically adopted in all discussions of hydrodynamics.

Maxwell[11] goes so far as to say:

> In the earliest times the most ancient philosophers whose speculations are known to us seem to have discussed the ideas of number and of continuous magnitude, of space and time, of matter and motion with a native power of thought which has probably never been surpassed.

It was a really profound insight into the nature of pure mathematics that led certain participants in the relativity discussion, at the last meeting of this society, to place in the same class the metaphysician and the mathematician; the new grouping of studies at Harvard College does the same; each of these subjects is concerned neither with phenomena of any kind, nor with individual purposes, but with those

[9] *Phil. Mag.*, January, 1910.

[10] "Encyclopedia Britannica," 23, 219.

[11] "Encyclopedia Britannica," art. Atom.

over-individual purposes, with those universal agreements, with that world-wide consensus of opinion, in which all sane men unite; in brief, mathematics and metaphysics each belong in the group which Münsterberg calls the "normative sciences." There is therefore a certain sense, which in passing I merely mention, but do not urge, in which all consideration of number and quantity and limits which the mathematical philosophers have handed down, increases the debt of physics to metaphysics.

Sound method in drawing inferences is a branch of science to which the physicist owns no copyright, but one in which he may claim to be fairly well versed. For this method he is indebted in no small degree to the development of logic in the hands of the metaphysician. In brief, modern physics, at its very inception in the seventeenth century, found that the schoolmen had already furnished it with a set of beautiful tools in the shape of fundamental logical ideas, including "precise definition," "classification," and "fallacies." Even Bacon when "preaching the funeral sermon of scholasticism," used the accurate methods of the schoolmen.

Space and time, as continuous quantities and as limiting conditions for all phenomena, is another conception of no small value which we have inherited from the Greeks. The critical examination of our conception of time, which was given by Einstein[12] some five years ago, and perhaps even earlier by Lorentz, had, among other interesting and more valuable features, the following: He showed clearly—and, so far as I am aware, for the first time—just what kind of "time" we have been and are still using in ordinary Newtonian mechanics, namely, time such as would result from having all our clocks controlled by a single central time-keeper *which would transmit its controlling signals with absolute instantaneity.*

The clear definitions of synchronous clocks and simultaneity—in brief the idea of local time—may be considered as belonging either to physics or to mathematics—but surely the exposition in which Einstein has taught us just what kind of time we have been unconsciously using for more than two centuries is a metaphysical contribution of high order.

The dangers of mere nominalism, or, if you prefer, extrapolation, by which I mean the danger of ascribing to any physical system a set of properties which we have merely learned to associate with its name, has been clearly pointed out in the history of philosophy. Due regard for this warning would, I believe, have saved many pages that have been written concerning the ether—especially those devoted to a determination of its inertia, its weight, and its place in the periodic table of Mendelejeff.

V. Limitations of Science

Fifthly and lastly the metaphysician has rendered the inestimable service of pointing out to the experimental investigator the paradox that his greatest strength lies in his confessed limitations. Each of the particular sciences views phenomena from its own particular angle; but there is, I fear, sometimes—often, indeed—a tendency for the student of physics to think that in measuring, say, the inertia of a body, he is in some sense getting at the "quantity of matter" in it; or to put it in another way, there is often a tendency to think that in determining the mass, on a beam balance, he is perhaps doing something more fundamental than merely determining inferentially the ratio of the

[12] *Ann. der Physik* (4), 17, 891–921 (1905).

inertia of this body to the inertia of some body selected as a standard; for which purpose he has abstracted the inertia from all other properties of body and is really no nearer the nature of the ultimate "substance" of the body than if he had measured its temperature or its color.

A most important limitation which might have been entirely forgotten were it not for the metaphysician, is the fact that *phenomena* do not constitute the *entire* subject matter of science. Indeed it is only the mental and physical sciences which deal with phenomena. Human purposes and acts of the human will are quite as much subjects of scientific study, whether we consider the individual, the group or the entire race of sane men, as are any of the phenomena of physics. It includes such branches as history, politics, language and literature. Not only so, but if we define the real as that with which we must reckon in the accomplishment of our purposes, this second group of sciences deals with subject matter which is quite as real as anything we consider in physics.

It will perhaps not be out of place here to repeat the warning given by President Maclaurin[13] to the American Chemical Society on the occasion of the recent Boston Meeting of the American Association for the Advancement of Science. He says:

> We should pay more serious attention than we usually do to the logic of science and have as clear ideas as possible as to what we are really aiming at, as to what we can really expect to do and not to do. A little artificial stimulus toward philosophy might accelerate the process. It seems to me extremely unfortunate that men of science are still so much scared by the bogey of metaphysics. . . . We should realize, perhaps, that a science such as chemistry is above all else a work of art, and that concepts like atoms, energy and the like are not much more than pigments with which we paint our pictures.

[13] *Boston Herald*, December 31, 1909.

Ether.—One other illustration must serve to complete this ungracious paragraph on limitations. I shall not weary you with citations from Lord Kelvin, telling us how much more we know about the ether than about ordinary matter, but I shall trouble you with a single sentence from that skilled expositor, Sir Oliver Lodge,[14] whose latest pronouncement upon this subject, omitting, however, the suppositions with which the entire argument is honeycombed, is as follows:

> The estimates of this book and of "Modern Views of Electricity" are that the ether of space is a continuous, incompressible, stationary fundamental substance or perfect fluid, with what is equivalent to an inertia-coefficient of 10^{12} grams per c.c.: that *matter* is composed of modified and electrified specks or minute structures of ether which are amenable to mechanical as well as electrical force and add to the optical or electric density of the medium: and that elastic rigidity and all potential energy are due to an excessively fine-grained etherial circulation with an intrinsic kinetic energy of the order of 10^{33} ergs per cubic centimeter.

Suffice it to say that I am second to no man in this society in my admiration for that group of men whose names are associated with the following dates—1676, 1728, 1820, 1831, 1845, 1864, 1888, Römer, Bradley, Oersted, Faraday, Neumann, Maxwell, Hertz; names and dates which mark the discovery of the finite speed of light, the discovery of aberration, the discovery of the magnetic field produced by an electric current, the discovery of the electromotive force produced by magnetic displacement, the mathematical formulation of this result by Neumann, the combination of these two results by Maxwell and the prediction from them of electric waves, the experimental realization of these waves by Hertz. For brilliancy of achievement this series has certainly sel-

[14] "Ether of Space," p. 151, Harper, 1909.

dom, if ever, been surpassed in the history of physics.

But leaving matter aside, and considering only the ether, what is the net result? Practically this, that *electromagnetic disturbances, including light waves, are propagated through space with a speed of 300 million meters per second.* This, I conceive to be the criticism which *every* sound metaphysician, but only *some* sound physicists, would pass upon our present knowledge of the ether. This is the one fact concerning the ether which we know in the same sense in which we are said to "know" the ordinary everyday facts of physics.

In conclusion, and still dealing with limitations, I beg to offer for your consideration a definition (*i. e., a* delimitation) of physics recently given to me by an eminent metaphysician.

Last summer I had the pleasure of several times meeting Professor Münsterberg; and on one of these occasions I took the liberty of submitting to him, for criticism, a definition of physics, which I myself had formulated. Following is his definition of the physics of to-day which he, in return, submitted to me and which is, I am inclined to think, unsurpassed in point of accuracy, clearness and completeness:

> Physics deals with changes in the world of over-individual objects, in so far as they are not changes of composition. It consists of those judgments which have proved themselves by trial to determine most accurately our justified expectations concerning these changes. In dealing with *objects* it separates itself from the knowledge of will-acts; in dealing with *over-individual* objects it separates itself from psychology; in abstracting from changes of composition, it separates itself from chemistry. The over-individual objects may be *matter* or *ether* or *electrons.*

CONCLUSION

The view of physics here presented is that of a half truth or partial truth. But this is very far from saying it is an untruth. The essential point—the only essential point—is for us to recognize the facts; to know ourselves; to admit our limitations. Then the more nearly we remain inside these limitations, and avoid "the den of the metaphysician," the better.

That flexibility of mind which it is desirable to secure *by not* translating every temporary opinion into a hard-and-fast fact of nature is well illustrated by a recent remark of Professor Schuster[15] who is himself one of the small group of men who have established the pulse theory of white light. "These two representations of white light (by homogeneous waves and by impulses) are," he says, "not mutually exclusive: They represent two points of view, and we may adopt either one or the other in different problems according to our convenience."

Less fixity and more flexibility in our views concerning the ether might, for instance, permit a more cordial consideration of Professor Osborne Reynolds's theory of gravitation which, so far as I understand it, has much to recommend it.

Lest what I said at the outset concerning the experimental side of physics should be forgotten, let me, in justice to myself, remind you once more of my attitude toward the experimentalist, towards that group which in Italy includes Galileo, Volta, Melloni and Righi; the skillful group which includes Oersted, Kirchhoff, Hertz, Roentgen; the French group of laboratory workers, Mersenne, Fresnel, Regnault, the Curies; in England, Gilbert, Boyle, Joule, Rayleigh; and those dextrous men, our own countrymen, Franklin, Henry, Rowland, Michelson. Toward the experimentalist as compared with the friendly critic and reviewer, my feeling is precisely that of Lincoln toward the soldiers who fought at Gettysburg. You all remember his sen-

[15] *Phil. Mag.,* (6), 18, 767 (1909).

tence—"The world will little note nor long remember what *we say* here; but it can never forget what *they did* here."

HENRY CREW
NORTHWESTERN UNIVERSITY

CHARLES REID BARNES

CHARLES REID BARNES was born at Madison, Ind., September 7, 1858, and died at Chicago, Thursday, February 24, 1910. He attended Hanover College, where he graduated with the degree of A.B. in 1877, being the valedictorian of his class. He was a student of Professor Coulter, with whom he was henceforth intimately associated professionally and otherwise until his death. After graduation he studied at Harvard University with Professor Gray, who regarded him as a man of great promise. In 1880 Barnes returned to Hanover College, where he was given the degree A.M. That same year he entered upon an instructorship of natural science at the high school, Lafayette, Ind., and later at Purdue University, where he was promoted to a professorship in 1882. In 1885 his chair was changed from natural science to botany and geology. In the year 1885–6 Professor Barnes again spent some time at Harvard University, and his *alma mater* in 1886 conferred upon him the degree Ph.D. In 1887 he was called to the chair of botany at the University of Wisconsin, whence in 1898 he was called by the University of Chicago to occupy its newly created chair of plant physiology, and here he remained until his death. From 1883 until his death he was associated with Professor Coulter in the editorship of *The Botanical Gazette*.

Professor Barnes was always prominently connected with the various scientific societies, having become a member of the American Association for the Advancement of Science in 1884 and a fellow in 1885. In 1890 he was secretary of the Botanical Club of the American Association for the Advancement of Science, and was secretary of the Botanical Society of America from its inception at Brooklyn from 1894 until 1898. In 1894 he served as secretary of Section G, in 1895 as secretary of the council of the American Association for the Advancement of Science, and in 1896 as general secretary of the American Association for the Advancement of Science. In 1898 he served as vice-president for Section G, American Association for the Advancement of Science, giving his retiring address at Columbus in 1899 on "The Progress and Problems of Plant Physiology." In 1903 he served as president of the Botanical Society of America, giving his retiring address at Philadelphia in 1904 on "The Theory of Respiration." In 1905 Professor Barnes served as a delegate from Section G, American Association for the Advancement of Science, to the international Botanical congress at Vienna. He was also a member of the American Society of Naturalists and of the Botanists of the Central States, and was in turn a member of influence in the state scientific academies of Indiana, Wisconsin and Illinois.

As a botanical contributor Professor Barnes began his career in a modest way in *The Botanical Gazette* in 1877, his first contributions, entitled "Notes," having to do chiefly with annotated lists of plants and additions to county floras, quite in the manner of the time. As early as 1879, however, some of his contributions reveal a strong physiological bent, the necessity of devices for accurate experimentation appealing to him then and ever afterward with unusual force. From 1883, when he became editorially connected with *The Botanical Gazette*, he gave freely of his time and energy to that journal. Much of the remarkable success of this periodical is due to his editorial genius; his trenchant English, and his insistence on accurate statement and mechanical perfection have for many years been reflected on almost every page. Perhaps no botanical reviewer has been so fearless as was Professor Barnes; frank but friendly disapproval of all that seemed bad, whether in fundamental principles, in statement of fact, or in mechanical alignment, was as natural to him as is fulsome praise to most reviewers. Possibly his greatest service to American botany was in his many-sided work on *The Botanical Gazette*.

Professor Barnés was first generally known

to the botanical fraternity through his taxonomic work on mosses, his first publication in this field being an "Analytic Key to the Genera of Mosses," published in 1886 as a bulletin of Purdue University; the following year was published a "Revision of the North American Species of *Fissidens*." In 1890 there was issued by the Wisconsin Academy of Science his "Artificial Keys to the Genera and Species of North American Mosses"; a revision of this work by Barnes and Heald appeared in 1897. There can be no doubt that these keys have greatly stimulated bryological study in this country, because the classic manual of the mosses (Lesquereux and James) is full of difficulties to all but the specialist in the group. A revision of *Dicranum* by Barnes and True practically completed the author's work in this field. While at Chicago Professor Barnes became greatly interested in the special morphological problems presented by the mosses and liverworts, and for several years there was offered in cooperation with Dr. Land a course in the special morphology of the bryophytes. In connection with this work Drs. Barnes and Land made extensive field studies and collections in Mexico in 1906 and 1908. There had already appeared two joint papers, one on "The Origin of Air Chambers" and the other on "The Origin of the Cupule of *Marchantia*"; several other joint papers are in various stages of completion, and are to be issued by the junior author. A general work on the special morphology of the bryophytes had been projected for the immediate future.

In plant physiology Professor Barnes's chief contributions were as a critical reviewer, as a teacher and effective guide in critical research, and as a sponsor for certain points of view. He was early a champion of the restricted use of the term plant food, as opposed to the broader usage, including water and salts. He also advocated long ago the use of the term photosynthesis (or photosyntax) in place of assimilation for the first stages in food-making, and he consistently advocated the restriction of sex terms to sex organs. The vice-presidential address of 1899, and even more the presidential address of 1904, gave stimulating physiological points of view much in advance of current usage. To few is it given to be so effective as a teacher and guide in critical research, and particularly to make clear the actual status of the subject when foggy and uncertain, as is the case in so many divisions of physiology. The botanists whom Professor Barnes has trained will through their teaching and their investigation carry on his ideals and reflect his powerful personality for yet many years. It is a source of intense gratification to his many botanical friends that Professor Barnes was able to revise the final proofs on the physiological part of a general work on botany that is expected soon to appear from the Hull Botanical Laboratory. In this there will be preserved the essence of his physiological point of view and something of his cogent reasoning and lucid style.

In 1898 Professor Barnes issued a botanical text-book for secondary schools, entitled, "Plant Life, Considered with Special Reference to Form and Function." This little book was about the first to deal particularly with physiology and ecology as subjects for study in secondary schools, and found a teaching public unprepared to use it, though the viewpoint here presented now dominates almost everywhere. A briefer edition of this volume, entitled, "Outlines of Plant Life," appeared in 1900.

To his botanical colleagues the death of Professor Barnes seems peculiarly premature, as he died from the effects of an accidental fall in full vigor and health, and just as he was about to round up in monographic form the results of years of study on the bryophytes. It was to have been expected also that before very long he would have incorporated his lectures to advanced classes on "Plant Physics," "Plant Chemics" and "Growth and Movement" into permanent form. To those who knew Professor Barnes intimately it is known that one of the foremost of our botanists has gone, a man great in many lines, and one who, in spite of his frank criticism and pitiless logic, was more than all a friend.

Henry C. Cowles

A NATIONAL BUREAU OF SEISMOLOGY

THE following resolutions were passed by the Seismological Society of America at a meeting held in San Francisco, on March 2:

WHEREAS earthquakes which are normally recurring phenomena of the earth's crust have in the past caused considerable loss of property and life, and much of the distress and destruction has been due to lack of knowledge of earthquakes and their peculiar mode of action and of proper precautions against injury and,

WHEREAS the magnitude of the destruction in the Atlantic coastal region (Charleston earthquake of 1886), the Mississippi Valley region (earthquake of 1812) and the Pacific Coastal region (California earthquakes of 1857, 1868, 1872 and 1906), makes it a matter of great import to all the people, and the fact that with increasing density of population the conditions are becoming more favorable for greater destruction in the future makes it important that action be not longer delayed,

WHEREAS the problems involved are of national and international character and local authority or private enterprise is insufficient to successfully carry on such work, and this fact has been realized already by many of the great nations including Germany, England, Japan, Austro-Hungary, Italy and Spain which have already established scientific earthquake services for the benefit of their peoples and the world at large,

Resolved that the Seismological Society of America strongly favors the establishment of a National Bureau of Seismology with power

(*a*) To collect seismological data,

(*b*) To establish observing stations,

(*c*) To study and investigate special earthquake regions within the national domain,

(*d*) To cooperate with other scientific bodies and organizations and individual scientists in forwarding the development and dissemination of seismological knowledge.

It also favors the organization of this bureau under the Smithsonian Institution with the active cooperation of other scientific departments of the government.

Resolved that copies of these resolutions be transmitted to the President, President of the Senate, the Speaker of the House of Representatives, Secretary of the Smithsonian Institution and the members of the House Committee on Library which has this matter now under consideration.

SCIENTIFIC NOTES AND NEWS

THE annual session of the National Academy of Sciences will be held in Washington, D. C., beginning Tuesday, April 19.

THE American Philosophical Society will hold a general meeting at Philadelphia on April 21, 22 and 23. On the evening of April 22, there will be a reception in the Hall of the College of Physicians, when Professor George E. Hale will deliver an illustrated lecture on "The Work of the Mt. Wilson Solar Observatory." The annual dinner will be held on the evening of April 23.

PROFESSOR GIOVANNI VIRGINIO SCHIAPARELLI, the eminent Italian astronomer, has celebrated his seventy-fifth birthday.

DR. WILHELM HITTORF, professor of physics at Münster, has been elected a member of the Paris Academy of Sciences.

PROFESSOR W. M. DAVIS, of Harvard University, has been elected an honorary member of the Società Geografica Italiana in Rome.

DR. W. J. HOLLAND, director of the Carnegie Museum, has been elected a corresponding member of the Royal Academy of Sciences, at Bologna, to fill the vacancy created by the death of Albert Gaudry, of Paris.

DR. A. HRDLIČKA, of the U. S. National Museum, has been made a corresponding member of the Anthropological Society in Vienna.

SIR WILLIAM RAMSAY has been nominated as honorary member of the Chemical Society of France.

SIR THOMAS BARLOW, F.R.S., has been elected president of the Royal College of Physicians, London, in succession to Sir Richard D. Powell.

DR. F. W. PUTNAM, honorary curator of the Peabody Museum of American Archeology and Ethnology, Harvard University; Dr. R. B. Dixon, assistant professor of anthropology and Dr. A. M. Tozzer, instructor in Central American archeology, have been appointed delegates of Harvard University at the foundation of the Mexican National University in September, 1910. Professor Dixon has also been appointed delegate at the Inter-

national Congress of Americanists to be held at the City of Mexico at the same time.

MR. H. H. CLAYTON, late of the Blue Hill Observatory, has gone to Buenos Ayres to organize kite and balloon observations under the direction of the Argentine Meteorological Service.

DR. SEBASTIAN ALBRECHT, of the Lick Observatory, has been appointed first astronomer in the National Observatory of the Argentine Republic.

THE annual address before the Huxley Society in the Johns Hopkins University was delivered Friday evening, April 1, by Professor W. P. Montague, of Columbia University. The address was on "Life and Mind as Forms of Energy."

PROFESSOR A. E. KENNELLY, of Harvard University, gave a lecture on March 12, to graduate students of the U. S. Naval Academy at Annapolis, on "The Operation of Electric Motors from a Central Power Station."

THE Aldred lecture of the Royal Society of Arts will be delivered by Professor H. H. Turner, F.R.S., on May 4, the subject being "Halley and his Comet."

MR. T. A. RICKARD, editor of the *Mining Magazine*, London, has been appointed lecturer on mining geology at Harvard University, where he will deliver a course of lectures at some time during the present year.

COMMITTEES of members and friends of Glasgow University have, says *Nature*, procured contributions to some £1500 for the purpose of commemorating the services of Dr. John Cleland, regius professor of anatomy from 1877 to 1909, and Dr. William Jack, professor of mathematics from 1879 to 1909, who retired last year. It has been decided to present to the university a portrait of Dr. Cleland, painted by Sir George Reid, with a replica for Mrs. Cleland; and a portrait of Dr. Jack, painted by Sir James Guthrie, and also a prize, to be awarded at intervals, for the best thesis on a mathematical subject approved for the degree of doctor of science during the preceding period.

IT is proposed to erect at Marburgh a monument in memory of Wilhelm Roser, who held the chair of surgery in the University of Marburg from 1850 to 1858.

MR. SAMUEL WARD LOPER, curator of the Museum of Wesleyan University, the author of contributions to geology and paleontology, has died at the age of seventy-five years.

MR. J. RAYNER EDMANDS, assistant in the Harvard College Observatory, died on March 26, at the age of sixty years.

THE death is announced of Dr. Eduard Pflüger, the eminent physiologist of Bonn, founder and editor of Pflüger's *Archiv*.

DR. OTTO HERMES, first director of the Berlin Aquarium, has died at the age of seventy-one years.

MR. CHARLES FOX-STRANGWAYS, for many years connected with the British Geological Survey, died on March 6, at the age of sixty-six years.

THE Central Branch of the American Society of Zoologists will hold its annual meeting at the University of Iowa on April 7, 8 and 9. The address of the president, Professor E. A. Birge, of the University of Wisconsin, is entitled "Some Personal Peculiarities of Lakes."

THE Association of German Scientific Men and Physicians and Medical Practitioners will hold its eighty-second meeting at Königsberg this year from September 18 to 24.

THE bequest of Miss Phebe Anna Thorne to the American Museum of Natural History has been applied as an endowment to the museum's room for the blind. Messrs. Samuel and Jonathan Thorne, the executors of the will, have increased the amount from ten thousand to twenty-five thousand dollars.

THE following course of illustrated lectures in economic entomology and genetics is to be given at the Bussey Institution of Harvard University, Forest Hills, on Sunday afternoons, during April and May, at 4 o'clock:

April 10—"Insects as Carriers of Disease. I. The House-fly and its Allies," by Professor W. M. Wheeler.

April 17—"Insects as Carriers of Disease. II.

Mosquitoes and their Allies," by Professor W. M. Wheeler.

April 24—"Mendel's Law of Heredity," by Professor W. E. Castle.

May 1—"Variation and Selection in Evolution and in Animal Breeding," by Professor W. E. Castle.

May 8—"The Gypsy and Brown-tail Moths," by Mr. C. T. Brues.

May 15—"Insects Injurious to Elm Trees," by Mr. C. T. Brues.

May 22—"Making New Plants by Selection," by Professor E. M. East.

May 29—"Making New Plants by Hybridization," by Professor E. M. East.

The Eastern Branch of the American Society of Zoologists at its recent meeting in Boston designated the following persons as a committee to cooperate with the commission on nomenclature of the International Zoological Congress: Dr. H. B. Bigelow, Museum of Comparative Zoology, of Harvard University, *chairman;* Dr. A. Petrunkevitch, American Museum of Natural History; Professor J. S. Kingsley, Tufts College; Dr. A. G. Mayer, Carnegie Institution of Washington; Dr. J. P. Moore, Philadelphia Academy of Natural Sciences.

One of the field courses announced in the Harvard Summer School is a physiographic excursion to be conducted by Professor W. M. Davis in the Rocky Mountains of Colorado during three weeks in July, beginning at Denver, July 6. The object of the trip is to study various features of mountain form, with special attention to the best method of describing them. The points to be visited are: the normal and glacial features of the highlands and continental divide of the Front range at the head of Boulder creek, crossed by rail at an altitude of 11,680 feet; the foot hills in the neighborhood of Golden and the valley of Clear Creek; the foot hills in the Garden of the Gods near Colorado Springs, and the fault-line escarpment of the Front range next to the south; the highlands west of Colorado Springs, over which Pikes Peak rises like a great monadnock; South Park, as an example of a high-level intermont basin; the upper Arkansas valley, as an example of a deeper intermont basin; the normal and glacial features of the Sawatch range west of the Arkansas valley; the Royal gorge of the Arkansas in the Front range, and the foot hills near Canyon city; the lava-capped Raton mesa near Trinidad; and the district of dike-walls on the denuded slopes of the deeply dissected ancient volcanoes, known as Spanish peaks. The conditions on which students (men only) may join the party can be learned on addressing Professor Davis, at Cambridge, Mass. The party will travel from place to place by train or wagon. making short distances on foot, and stopping in hotels over night with possibly one or two nights in camp.

Letters have been received at the Harvard College Observatory from Professor E. B. Frost, director of the Yerkes Observatory, giving the following observations by Professor Bernard: Comet *a* 1910 was observed March 12, 1910, at $16^h 56^m$ central standard time, in R. A. $22^h 24^m 39^s$ and Dec. $+15° 37'.3$ (1910.0). "The comet was of the ninth magnitude, strongly condensed, possibly to a very faint nucleus. No tail noticed." A photograph of the same comet was obtained at dawn on March 14. No tail was shown on the plate with an exposure of nine minutes. Photographs made with all three lenses of the Bruce telescope, the exposure being $1^h 50^m$, failed to show any trace of the comet reported by Pidoux. These plates show a tail to Halley's comet nearly a degree long. A photograph of Comet *a* 1910 at dawn on the morning of March 15, the exposure being 35^m, shows a faint tail two degrees long.

The North Dakota Geological Survey has recently published the fifth volume of its series of reports dealing with the geology and natural resources of the state. The present report, which is a volume of 278 pages, with many illustrations and maps, contains papers on the geology, topography and coal deposits of southwestern North Dakota, including the Little Missouri badlands; the geology of the northeastern portion of the state with particular reference to the natural cement rock of that region; together with chapters on the

geology of North Dakota as a whole, on natural gas and on good roads. Previous reports of the Survey have described the extensive and valuable clays and lignites of the state, the fourth report being devoted entirely to the clays, particularly the high grade fire and pottery clays. Last summer the geology and natural resources of the area comprised in the Bismarck quadrangle was investigated by the State Geological Survey in cooperation with the United States Geological Survey. These two surveys are also cooperating in the collection of data regarding the deep wells of the state, and this work will be pushed as rapidly as possible. During the coming summer the study and mapping of the geological formations of south-central North Dakota will be continued, and work will also be undertaken on the physiography and geology of the interesting Devils Lake region.

It is stated in *Nature* that the director of the British Meteorological Office has given notice that from April 1 forecasts of the weather prospects more than twenty-four hours ahead will be issued as opportunity is afforded. Applications have been received at the Meteorological Office from time to time for forecasts of weather several days in advance, in addition to, or instead of, the usual forecasts which refer to the twenty-four hours reckoned from the noon or midnight following the issue of the forecasts. According to the experience of the Meteorological office, the weather conditions do not usually justify a forecast detailing the changes of weather for consecutive days. There are a number of occasions in the course of the year when the distribution of pressure is typical of settled weather, and also occasions when the conditions are characteristic of continued unsettled weather. On these occasions, and on a few others when the sequence of the weather is of a recognized type, a sentence giving in general terms the outlook beyond the twenty-four hours of the definite forecast might be useful to the general public, and, as it could be justified by the statement of definite reasons for the inference, it would come within the general rules laid down by the office with reference to the issue of forecasts. An indication of the general prospect extending beyond the twenty-four hours' limit is frequently given in the "General Inference" which precedes the forecasts for the several districts on the sheet issued to newspapers. It is expressed in more or less technical language, and the application to the several districts might only be followed by persons acquainted with the terminology used in weather study. It is proposed, therefore, when the meteorological conditions permit, to supplement the forecasts for districts by a remark on the further outlook.

UNIVERSITY AND EDUCATIONAL NEWS

Among recent endowments to the New York Polyclinic Medical School and Hospital, the first post-graduate medical school in the United States, are one of $250,000 by Mr. William P. Clyde, and another of $125,000 by Mrs. Helen Hartley Jenkins.

Mr. Andrew Carnegie has given $40,000 to Wells College for the building of a library to be called the Frances Cleveland Library in honor of Mrs. Grover Cleveland, who is a graduate of the college.

The main building of the Texas Christian University has been destroyed by fire, entailing a loss of $125,000.

President Noble has issued a formal announcement of the fact that, by order of the board of trustees and by act of the General Assembly of Maryland, the corporate name of the Woman's College of Baltimore has been changed to Goucher College.

In the Medical School of the University of Pennsylvania Dr. Alonzo E. Taylor, now of the University of California, will become professor of physiological chemistry; Dr. Henry T. Ricketts, of Chicago University, will occupy the chair of pathology, and Dr. Richard M. Pearce, of Albany, will be professor of experimental medicine. Dr. Allen J. Smith, while retaining his position as dean of the school, will be transferred to a chair of comparative pathology and be at the head of the courses in tropical medicine.

PROFESSOR SAMUEL C. PRESCOTT has been appointed acting head of the department of biology of the Massachusetts Institute of Technology, during the absence in Europe of Professor W. T. Sedgwick.

DR. E. H. CAMERON, instructor in psychology in Yale University, has been advanced to the grade of assistant professor. In that institution Dr. F. S. Breed, now engaged in graduate work in comparative psychology at Harvard University, has been appointed instructor in psychology.

MR. ALAN S. HAWKSWORTH has been appointed professor of higher mathematics in the University of Pittsburgh.

AT Haverford College Professor A. H. Wilson, of the Alabama Polytechnic Institute, has been appointed to the position of associate professor of mathematics in place of Professor Jackson, who returns to England.

WILLIS T. POPE, professor of botany in the College of Hawaii, has been appointed by the governor, superintendent of public instruction for Hawaii. Vaughan MacCaughey (Cornell, '08), has been appointed to fill the vacancy in the college.

DISCUSSION AND CORRESPONDENCE

SOME ADDITIONAL CONSIDERATIONS AS TO THE CARNEGIE FOUNDATION

TO THE EDITOR OF SCIENCE: Several contributors to your journal have recently discussed the change of policy announced by the Carnegie Foundation; two considerations, however, have not been mentioned either here or elsewhere to my knowledge.

First, the obligations on the part of the foundation toward those formerly denominational colleges which have in the last four years secured changes in their charters severing their relations with the parent denomination. The reports of the foundation have mentioned several of these institutions, and others have come within my notice. In all these cases, the foundation held out to these institutions the promise of certain benefits if they would sacrifice the historic association with the people who founded the school. These benefits were essentially two,—the privilege to professors of retiring after twenty-five years of service, and of retiring on a somewhat higher pension at the age of sixty-five. Now, in the present situation, these colleges find themselves left with only a small fraction of the benefit anticipated, for nobody will deny that the service pension was a much greater inducement than the age pension. And the most disquieting thing about it is that this great foundation in no way intimates a consciousness of having treated anybody unjustly.

Second, as to the state universities. If the service pension be discontinued, has the foundation anything to offer to the professor in such an institution? Is there a state university in the land where a professor sixty-five years of age with a fifteen-year (and generally a thirty-year) record in the institution behind him is in danger of losing his position? I think not. On the contrary, my impression is that the old professors are universally held in such respect, and their lives are so interwoven with the history of the school, that no one thinks of dismissing them in their old age. Possibly in some small and poor private colleges of the country the condition of the exchequer may make it hard to do justice to old professors, but no state university can afford to deal otherwise than generously with such cases. But what will the foundation do for them when they reach the age of sixty-five? It will "automatically, and as a matter of right, and not as a charity," reduce their salaries about fifty per cent.! As an offset to this, there is the possibility of a disability pension, and the probability of a pension to the widow of a professor. It would take considerable actuarial ability to figure out whether the professor and his wife are ahead or behind when both sides are considered. It is easy to see that the foundation has virtually made a contribution to the treasury of the university, but has it on the whole done anything to compensate the professor for the privations of a life time of poorly paid service, as so generously desired by Mr. Carnegie when he made his first gift to the foundation?

J. M. ALDRICH

UNIVERSITY OF IDAHO,
March 30, 1910

[The Carnegie Foundation for the Advancement of Teaching is of such importance for education and science that we should be pleased to see all aspects of the subject thoroughly discussed in this journal. As the communications hitherto received have been critical, we should like to have letters emphasizing the services of the foundation and defending the recent action of the trustees.—ED.]

KAHLENBERG'S CHEMISTRY

TO THE EDITOR OF SCIENCE: "The penalty of being oracular is that fashions in oracles change." This clipping from a daily paper was called to mind by reading Lewis's recent review of Kahlenberg's excellent text. In this review, one whose experience is slight in teaching the first-year student gives us exact advice as to what the beginner should be taught.

Among chemical circles, the first-year course stands much as Walker used to describe the position of political economy among popular sciences. Every man thinks he is capable of taking part in a subject of such general interest. The citadel has been assailed by every new fad in chemistry until it is a by-word that, compared with mathematics and the classics, chemistry stands out prominently characterized by the unsettled conditions of its pedagogical method.

While admitting the greatest appreciation of the value of those topics for which Lewis argues so ably (as though physical chemistry needed to be propagated and popularized) the question which is most important and which the reviewer does not discuss is the suitability of these topics for first-year students. This is, I imagine, clearly answered by the fact that by far the larger number of college teachers, after studying the presentation of these topics, are not including them in the first-year course. And this is not through ignorance, as Lewis implies, but through judgment born of experience with first-year students. The chemistry of a "generation or more ago" still lives and is ready to say to its youngest branch that it does not pay to rail at one "who has the age on you."

It is unfortunate that the reviewer, because he must ride his hobby and perhaps because he feels that the confidence which he formerly had in the ionic hypothesis has been somewhat weakened by this same Kahlenberg, should have forgotten to point out how excellently each chapter in the text under discussion is presented—how Kahlenberg's rich experience has brought him close to a knowledge of just what the beginner wants to know in the way he wants to have it presented—the beautifully balanced thoughts, the logical sequence. I have just finished reading the chapter on Sulphur. In my opinion, those of us who are teachers and are not afraid to introduce as much of the ionic hypothesis as our pupils need will have already decided with the writer that we have here the work of a master in the good old art of teaching.

The question of what may and what may not most suitably be provided for the beginner should be left for discussion to the section of chemical education; but if I may be allowed to restate from a recent address at Ann Arbor, it is not a question, in the first year, as to what we think it would be desirable for all students of chemistry to know. It is rather the "care and feeding of children" which is thrust upon us for discussion. It is perhaps because we do our work so well, concealing the difficulties, that the teachers of advanced work and the specialist think we can impose anything upon the students and succeed.

In conclusion, would it not be better if the task of reviewing a work which stands for years of enthusiastic interest and successful experience among beginners should be given to one whose interest, as expressed in the review, is sympathetic with pedagogical problems?

ARTHUR JOHN HOPKINS
AMHERST COLLEGE

BOTANICAL-EDUCATIONAL INFORMATION WANTED

TO THE EDITOR OF SCIENCE: In connection with certain important committee work for the Botanical Society of America, I need to know exactly which universities, colleges and technical schools in this country accept the College Entrance Examination Board's certificates for examinations passed upon its one-year unit (or course) in botany, counting

about one point out of fourteen for admission. My present data, derived from official sources, here follow, but they are, for sundry reasons, incomplete. I wish to request that any reader of this note who is connected with a university, college or technical school, will make sure whether his institution is correctly represented in the lists below, and if not I shall be very grateful if he will communicate to me the suitable correction. I shall later publish a supplementary list, and finally a complete one in connection with other related data.

The following institutions accept the College Entrance Examination Board's examinations in botany, and state the fact in their official publications: Bryn Mawr, California, Cincinnati, Columbia, Cornell, Dartmouth, Harvard (although it can count for only a half year), Illinois, Leland Stanford, Maine, Massachusetts Institute of Technology, Massachusetts Agricultural College, Mount Holyoke, Nebraska, Northwestern, Ohio, Pennsylvania, Rochester, Simmons, Smith, Syracuse, Washington (St. Louis), Wellesley, Wells, Vermont, Woman's College of Baltimore, Yale Scientific School.

The following institutions, I am assured, accept the board's examinations, although at last accounts no mention of the fact had been made in their official publications: Chicago, Haverford, Kansas, Minnesota, Missouri, North Carolina, Oberlin, Wabash, Williams.

W. F. GANONG

NORTHAMPTON, MASS.

SCIENTIFIC JOURNALS AND ARTICLES

THE contents of the March issue of the *Journal of Terrestrial Magnetism and Atmospheric Electrictiy* are as follows: "Scientific Staff and Crew of the *Carnegie* at Falmouth, England, October, 1909" (Frontispiece); "Completion of the First Cruise of the *Carnegie*"; "The Present State of Our Knowledge of Magnetic Materials," A. A. Knowlton; "Beginning and Propagation of the Magnetic Disturbance of May 8, 1902, and of Some Other Magnetic Storms," L. A. Bauer; "Analysis of the Magnetic Disturbance of January 26, 1903, and General Considerations Regarding Magnetic Changes," L. A. Bauer; "The Magnetic Storm of September 25, 1909, at de Bilt, near Utrecht, Holland," G. van Dyk; "Discontinuance of the Baldwin Magnetic Observatory and Establishment of the Tucson Magnetic Observatory," R. L. Faris; "Principal Magnetic Storms Recorded at the Cheltenham Magnetic Observatory, October–December, 1909," O. H. Tittmann; "Aurora Borealis observed at Beinn Bhreagh, near Baddeck, Nova Scotia, September 21 and October 18, 1909," A. G. Bell; "Magnetic and Allied Observations in connection with Halley's Comet"; "Hellmann's Bibliography of Magnetic Charts," L. A. B.; "Galitzin, Arnold, The Beginning of an Earthquake Disturbance," H. F. Reid; "The Tenth Edition of Müller-Poullet's Physics (Vol. IV., Pt. 1)," W. G. Cady.

SCIENTIFIC BOOKS

Radiation, Light and Illumination. A Series of Engineering Lectures Delivered at Union College. By CHARLES PROTEUS STEINMETZ, A.M., Ph.D. Compiled and edited by JOSEPH LE ROY HAYDEN. Pp. xii + 305. New York, McGraw-Hill Book Company. 1909.

This latest book from the pen of Dr. Steinmetz constitutes to some extent a departure from his previous writings. In it an attempt, perhaps the first definite attempt, has been made to bring together not only the principal physical facts, but also many of the more important physiological facts which pertain to the effects of luminous and attendant radiation. The view-point throughout is that of the engineer. The book is the outcome of a series of lectures to engineering students. It is intended in the author's words in the preface "not merely as a text-book of illuminating engineering, nor as a text-book on the physics of light and radiation, but rather as an exposition, to some extent, from the engineering point of view, of that knowledge of light and radiation which every educated man should possess, the engineer as well as the physician or the user of light."

With the exception of a few chapters there

is no mathematics, and throughout there is evidence of a desire to make the book attractive to the non-technical reader. It is somewhat doubtful, however, whether the book will appeal to many except students or technical men who desire a brief but comprehensive survey of certain phases of illuminating engineering. As a whole the book is suggestive, and should be of distinct value in helping to correlate the various phenomena of physics and physiology on which the scientific side of illuminating engineering rests.

It would scarcely seem, however, that a text-book for students, or an exposition for the general educated public, should be the proper place to introduce new ideas and terms which have not yet been accorded general acceptance by scientific writers, and yet the present book contains many such innovations. Wave-lengths are expressed in micro-centimeters (cm. $\times 10^{-6}$) on the ground that there are several other systems in use, none of which is scientifically accurate (p. 7) according to the C.G.S. system; and yet several pages further on (p. 16) a sudden jump is made from centimeters to feet. The classification (p. 20) of "the total range of known radiations" into "the *electric* waves and the *light* waves" would scarcely seem orthodox or clarifying, particularly as the "light" waves are made to include even X-rays.

In Lecture IX. a number of types of photometers, some of them quite primitive, are described, and several pages are given to a description of a so-called "luminometer" which employs the old but sometimes very useful method of "reading distances," whereas no mention has been found of one of the most common, and perhaps the most accurate photometer in use at the present day for comparing lights of approximately the same color—the Lummer-Brodhun photometer in its two forms. Even the very familiar Bunsen photometer, though mentioned by *name*, is nowhere described. The photometer shown in the diagrammatic sketch and described under the name "Bunsen" on page 170 is in reality a simple Ritchie wedge, distinctly different from the "grease spot" photometer invented by Bunsen, or even the more recently improved Leeson disk which is sometimes substituted for it. Again (p. 260) it would seem that too little weight is given to the accepted definition of "illumination" compared with the author's idea of what this term should indicate.

Lecture III., Physiological Effects of Radiation, would seem to the reviewer to be very unfortunate in its manner of presentation. As the present knowledge in this field, particularly in regard to the "pathological and other effects on the eye," is quite restricted, and only to a very limited extent satisfactorily established, one is likely to wonder whether the many positive statements are correct expressions of accepted facts or merely speculation. Here, particularly, a few references to authoritative sources of information would be appreciated. It is perhaps questionable whether the various harmful effects of light on the eye can be so readily classified into the two distinct groups, "power effects" and "specific effects of the shorter waves." It is quite probable that a definite large amount of radiant energy incident on the eye would be capable of producing entirely different results if all of the energy were in the infra-red, or if all were concentrated in the most luminous portion of the visible spectrum. We can look at an incandescent mantle or an incandescent filament for a brief period without any pronounced feeling of pain, but what would the result be if all of the radiant energy from these sources could be transformed into light, even of the longer wave-lengths where the so-called "specific effects" presumably do not enter? The dazzling glare in such an experiment, were it practicable, would very probably be distinctly painful. In general it is necessary to consider the quality in conjunction with the quantity, so that the classification suggested would scarcely seem justified. Moreover, it would seem wise to discriminate between those effects which pertain to the anterior portions of the eye as in the absorption of large quantities of ultra-violet radiation, and those harmful effects which are retinal.

Lecture V., Temperature Radiation, gives a very brief résumé (with a new notation) of the laws of temperature radiation. In the generality of the statements, however, accuracy is ofttimes overlooked. It is not true that (p. 74) "Practically all bodies give the same temperature radiation, *i. e.*, follow the temperature law (1)" (which states that the total emissivity is proportional to the *fourth* power of the absolute temperature). For most substances investigated the exponent should be greater than "4," in some cases (see recent investigation by Coblentz, Bureau of Standards Bulletin, Vol. 5, p. 339) as large as 6 or even 7. Little attention is given to the effect of selectivity (though slight mention is made of it) in determining the high efficiencies of some sources, such, for example, as the osmium lamp. It is at least questionable whether (p. 80) the melting point of osmium is higher than that of tantalum merely because it can be operated at a higher efficiency. Osmium undoubtedly is distinctly selective.

On the whole, although the book is extremely interesting to the technical reader and is quite suggestive, there would appear to be a lack of care in gathering together the facts, and a somewhat too dogmatic style in presenting those topics which are still more or less in the domain of speculation. The color pyrometer described on pp. 89–90 is apparently a real instrument, but any attempt to reproduce it would soon convince one that no mixture of spectrum yellow and spectrum blue would give a green that could be matched in hue with spectrum green. Numerous small errors, both typographical and factual, could be cited, but would scarcely strengthen the conclusion that an early revision of the book would be most welcome.

The reviewer desires, however, to express his appreciation of the service which this book has rendered in coordinating the closely related phenomena of physics and physiology in their relation to illumination, and in calling attention to many vital questions of illumination which are frequently given too little attention in practise (such as those of directed and diffused illumination, shadows, the effects of sources of high intrinsic brightness in the field of view, etc.).

Edw. P. Hyde

Physical Laboratory,
National Electric Lamp Association,
Cleveland, Ohio

Die Säugetierontogenese in ihrer Bedeutung für die Phylogenie der Wirbeltiere. Von A. A. W. Hubrecht. Jena, Gustav Fischer. 1909. Pp. 247, 186 text figures.

Most zoologists know that Professor Hubrecht has been an assiduous student of mammalian embryology for many years. The reviewer well remembers the beautiful preparations—probably of *Tupaja*—exhibited by the author at the Oxford meeting of the British Association in 1895.

The appearance of a volume on the subject from such experienced hands may be supposed to be an occurrence of no little interest to students and teachers in this province of biology. Whether the volume that actually comes to us fulfills expectations depends largely on what the particular user may feel in need of, and what his standpoint may be with reference to the more general problems involved.

If one be chiefly desirous of a manual that should set forth the main facts of mammalian development positively ascertained up to the present moment, along with such generalizations as a conservative zoologist might recognize as truly illuminating and not objectionably forced, the book can not be very satisfactory, so it would seem.

If, on the other hand, one would wish to see how strong a case a competent specialist can make of a fundamental theory of his own, then the work may be adjudged satisfactory. What we have essentially is a case of special pleading, as indeed the title permits if it does not intend us to infer. Not mammalian ontogeny, but such ontogeny in its significance for vertebrate phylogeny, is the aim.

This statement is not intended to give the impression that the reader longing for facts primarily will find nothing to his purpose. Not only the text but the many figures present very many facts. Such a summary, for ex-

ample, as is given on page 3, of the chief works on the cleavage of mammalian eggs, should be highly appreciated by the general student.

There are in all six chapters, as follows: I., The First Cell Layers—(A) Of the Monodelphic and Didelphic Mammals; (B) Of the Ornithodelphic Mammals and Sauropsida, and (C) Of the Ichthyopsida. II., Farther Development of the two Germ-layers of the Vertebrata up to the Origin of the Somites. The Mammalia, the Amphibia, the Sauropsida and Ornithodelphia and the Fishes are treated. III., Diplotrophoblast-Serosa (Subzonal) Membrane, Chorion, Allantois and "Nabelblase" in Onto- and Phylogenesis. IV., The part taken by the Trophoblast in the Nutrition and the Attachment of the Embryo. V., Various Points (Verschiedenes) on Placentation. VI., Considerations Touching the Phylogeny and the Systematic Divisions of the Vertebrata.

These contents of the chapters will suffice to show that as regards embryology proper only the very early stages are dealt with. Organogenesis does not fall within the scope of the work. The undertaking is such, too, that vertebrates other than mammals receive large attention. Of the 186 figures nearly one fourth are not mammalian, the larger number of these outsiders being of fishes, amphibians and reptiles.

As to exactly how much weight should be attached to Hubrecht's theory in its various ramifications (his trophoblast theory) only a student of the vertebrata can tell who is more experienced than he, and is far less of a special pleader. But any zoologist who is moderately well informed first hand in general vertebrate morphology and embryology, and who has likewise occupied himself in a serious way with problems of phylogeny, can readily see that the best that can be said for the most far-reaching contentions is that they may *possibly* be true. While it may be legitimate for a zoologist to find a measure of satisfaction in recognizing the various possibilities as to what the course, or rather courses, of vertebrate evolution may have been, it is well never to lose sight of the fact that what is only possibly true is probably not true.

Hubrecht has pointed out facts enough to make it *possible* that his "vermactinial stage in vertebrate phylogenesis," figured on page 22 and again on page 228, was a reality in some remotely past time. But dozens of other facts which he has not alluded to make it *probable,* to the reviewer's mind at least, that no such ancestral stage ever did exist.

Such a hypothetical creature would be harmless, indeed might have a certain usefulness, could it be presented merely as one among numerous possibilities, for if so presented it would not be chargeable, as it is almost sure to be when claiming exclusive rights, with distorting the facts upon which its existence depends; and it, along with its alternatives, might then help the mind to grasp the general truth that the actual animals dealt with have arisen by a natural, that is, an evolutionary process.

LA JOLLA, CAL. WM. E. RITTER

THE SILKEN-HAIRED ONES

WHAT "Black Beauty" did for horses President Jordan's "Story of Matka"[1] ought to do for the unfriended fur-seals of the Bering Sea. The ruthless slaughter of these seals which will end, if not soon interrupted, in their certain extinction, is a hideous present-day world crime of which three great powers are openly guilty. In 1880 two and a half million fur-seals lived in Bering Sea. In this year 1910 of enlightened civilization, scientific knowledge and Christian sweetness and light there are still by good fortune alive 150,000 of these beautiful, silken-haired, soft-eyed creatures of nature's choicest making. The others have been slaughtered as mothers or starved as children by the refined methods of diplomacy cultivated by Great Britain, Japan and the United States.

Dr. Jordan wrote the "Story of Matka" on the very rocks where Matka lived, with Matka the mother seal and Kotik, the baby seal and Atagh, the grandfather and Eichkao, the blue

[1] "The Story of Matka," by David Starr Jordan. San Francisco, Whitaker-ay-Wiggin Co., 1910.

fox that "clin-n-g, clin-n-g-ed like a scared buzz-saw," and wise old Eparka, the sea-parrot, all under his keen eyes. He was there as the special correspondent of the great newspaper "Beneficent Science" which is published for the amusing, informing and guiding of all the men and women of the world. But the story moved no man nor woman; that is moved none to action. Or rather it did not move the needed many to compel the action that is necessary if the few Matkas and Kotiks that are left are not to be the last of their kind.

So now the story is reprinted in such form that it is to be offered to the children of the land to see if perhaps they may not feel more and do more than their fathers. It is a well-illustrated, simply told true tale, at once charming and pathetic, fascinating in its revelation of the wonderful ways of a child-bearing and child-teaching wild animal of the mist-wrapped islands of the north, appealing to every chord of sympathy and rousing to every instinct of antagonism for brutal cruelty.

V. L. K.

Laboratory Manual of First Year Science for Secondary Schools. By RUSSELL and KELLY. New York, Henry Holt & Co. 1909. Pp. 163.

This book gives the first printed account of the rather famous Springfield course in general science introduced five years ago by Dr. Thomas M. Balliet and Wm. Orr, then respectively superintendent and principal of high school, at Springfield, Mass.; now, respectively, dean of the school of pedagogy, New York University, and deputy commissioner of education of the state of Massachusetts. The authors have developed this course in great fidelity to the ideas and suggestions of their superior officers.

The purpose of the course is twofold: "(1) To give the pupil a broad general view of the whole field of science, (2) to explain to the pupil his every-day environment."

The work as it is conducted in Springfield is in a large measure informational, with abundant experimental illustration to make the knowledge *real.* The lecture by the teacher, and the investigation by the pupils of matters to be found outside of the school, are the most effective features of the course.

The course is required of all first-year high-school students (those who have visited the school know that it would be easier to require than to prevent their taking it).

The course is flexible and changes from year to year and is, after all, a *"method of instruction"* rather than a *"course of study."* Such topics are treated as the following:

Reading of gas meters, water meters, electric meters, reading of water pressure and steam pressure gauges, water tests, charcoal filters, litmus tests, removal of stains, coal tar dyes, food tests, heating and ventilation, uses of the electric magnet, constellations, standard time, weather reports, candle power of light, cost of lights, germination of seeds, leaves, mould, building stones, ores.

JOHN F. WOODHULL

COLUMBIA UNIVERSITY

SPECIAL ARTICLES

PULSATIONS IN SCYPHOMEDUSÆ DEPRIVED OF THEIR MARGINAL ORGANS

WHILE working at the Harpswell Laboratory, I found that the two Scyphozoa so common on the coast of Maine, *Aurelia flavidula* and *Cyanea arctica,* responded differently to operations on the marginal organs. The European species of these two genera have been studied by Eimer and Romanes, with respect to this point and these two men were unable to agree as to the behavior of the animals with excised marginal organs. Mayer has stated that *Aurelia* (he does not specify the species) is temporarily paralyzed when the marginal organs are excised and this agrees with my observations. Eimer, too, reached a similar conclusion, but Romanes's experiments led him to state that, while many specimens did regain their pulsations, although always irregular and obviously different from those of a normal specimen, yet the greater majority remained quiescent.

Romanes failed to be as explicit in his statements concerning the behavior of these

jelly-fishes as he has in his other writings, and it is not a matter of surprise that he should be quoted[1] as saying that the forms with which he worked became paralyzed, when the marginal organs were excised, when one reads[2] that he found "in all the species I have come across that excision of the margins of the umbrellas produces an effect analogous to that which is produced by excision of the margins of the Hydromedusæ" where such an operation results in the total paralysis of the bell. However, when one reads farther, he says, with much verbosity, that

> There is an important difference, however, between the two cases in that the paralyzing effect of the operation on the umbrellas (of the Scyphomedusans) is neither so certain nor so complete as it is on swimming bells (of hydromedusæ). That is to say, although in the majority of experiments such mutilation of umbrellas is followed by immediate paralysis, this is not invariably the case.

Romanes found that *Aurelia aurita* showed "instantaneous and complete paralysis of the gonocalyx" on excision of the marginal organs, while *Cyanea capillata* was less marked in this respect.[3] Eimer's observations were practically the reverse of this.

There can be no question that Romanes was entirely correct in his observations, for he repeated them during several summers, specifically examining the point in question in the light of Eimer's work. It is fair to assume, too, that Eimer made no mistake. Hence, it seems that *Aurelia aurita* reacted differently on Cromarty Firth, Scotland, from what it did in the North Sea with respect to the matter at issue. Romanes probably used a different species of *Cyanea* (*Cyanea capillata*) from Eimer's form (which was probably *Cyanea lamarckii*) and I have used a third species, *Cyanea arctica*, which seems to be recognized by systematists as a good species. My species of *Aurelia*, *Aurelia flavidula*, is recognized by some as distinct from *Aurelia aurita*, but both Louis and Alexander Agassiz did not so regard it.

From my observations, *Aurelia flavidula* very rarely is paralyzed completely and, indeed, I have but an impression that I have seen *Aurelia* absolutely quiescent after the marginal organs have been removed. Unfortunately, I did not examine the question critically until last year and my previous observations were not recorded. During the past year, however, I found no specimen which did not regain pulsation after a longer or shorter period after the marginal organs were removed. The case of *Cyanea* is directly the reverse, for this form becomes totally paralyzed when the organs are removed. Reference to the statements from Eimer and Romanes, given above will make it clear how these observations correspond to theirs. They agree closely with those of the former and are totally at variance with those of the latter.

The matter is of importance from the point of view of the physiologist who wishes to use some primitive form of contractile substance with which to experiment and these observations are especially directed to them. *Cyanea arctica* will remain quiescent after the marginal organs are removed and respond only to mechanical, chemical and other external stimuli supplied by the operator. In fact, *Cyanea* rivals the classic *Cassiopea* for experimental work. *Dactylometra* reacts like *Aurelia flavidula*.

MAX MORSE

NEW YORK,
March 8, 1910

[1] For instance, Parker in his *Popular Science Monthly* articles on the nervous system makes such a statement and while giving no references, yet he has written me that he was impressed that Romanes's observations led to such conclusions.

[2] "Jelly-fishes, Starfishes and Sea Urchins," Appleton.

[3] *Phil. Trans.*, Vol. 167.

THE SOCIETY OF AMERICAN BACTERIOLOGISTS

THE eleventh annual meeting of the Society of American Bacteriologists took place on December 28, 29 and 30, 1909, in the administration building of the Harvard Medical School, Boston, in conjunction with the annual meeting of the American Association for the Advancement of Science. It can be confidently asserted that the society has never held a more successful and profitable meet-

ing, both as regards the numbers in attendance and the quality of the papers presented. The president of the society, Professor J. J. Kinyoun, occupied the chair at all of the sessions. The reports of the secretary and treasurer showed that the affairs of the society were in a healthful condition.

The nominating committee placed before the society the names of the following for election to the offices for the ensuing year, and they were unanimously declared elected:

President—Professor V. A. Moore, Cornell University.

Vice-president—Professor F. P. Gorham, Brown University.

Secretary and Treasurer—Professor C. E. Marshall, Michigan Agricultural College.

Councillors—Messrs. Prescott, Amyot, Stevens and Harris.

Delegate to the Council of the American Association for the Advancement of Science—Professor Erwin F. Smith.

The report of the committee on the identification of bacterial species was presented and adopted. As it is of an important nature, it is given here in full: (1) The standard card for the description of species has proved highly satisfactory in the hands of those who have given it a thorough trial. The maximum benefit from the card can only be realized, however, as its use becomes still more general. The committee, therefore, wishes again to urge upon the members of the society the great value of this method of recording bacterial characters. Advantage will accrue not only to the individual investigator, but in still higher degree to other workers on account of the comparability of the data thus obtained. (2) The numerical system of recording bacterial characters, while valuable for cataloguing cultures, must necessarily fail to approximate the natural classification of species. The method which at present seems most promising for determining the true relationships of these microorganisms is the statistical or biometric method. Bacterial species may most satisfactorily be defined by the quantitative study of measurable characters in a considerable series of cultures, the modal points or centers of frequency being given specific names, and larger groups having a number of common characters receiving the rank of genera or families. The committee urges upon the members of the society the importance of further systematic investigation along this general line. (3) In view of the great value of biometric classification to all workers in bacteriology the committee suggests the following resolution:

Resolved, That the Society of American Bacteriologists, recognizing the importance of a systematic study of bacterial species by the statistical method and the necessity for financial assistance in carrying out work which involves so large a proportion of routine, authorizes the committee on identification of bacterial species to present this need to any persons or institutions having charge of the distribution of funds for assisting scientific research.

(4) Finally, the committee believes that it would be of great advantage if descriptions and cultures of all new species or varieties could be submitted to some central bureau where they might be studied and compared and kept in such condition that bacteriologists could at any time obtain duplicate descriptions and subcultures for their own use. The committee therefore recommends the following resolution:

Resolved, That the Society of American Bacteriologists believes that the establishment of a central bureau for the preservation and distribution of descriptions and type specimens of the bacteria would be of great value to all workers in science.

F. P. GORHAM
C.-E. A. WINSLOW

The council declared four vacancies to exist in the membership of the society and the following were elected to fill those vacancies: Dr. G. W. Stiles, Department of Agriculture, Washington, D. C.; Professor W. E. King, Kansas State College of Agriculture, Manhattan, Kans.; Professor R. E. Buchanan, Iowa State College of Agriculture, Ames, Iowa; Professor Oscar Klotz, department of pathology, University of Pittsburgh, Pittsburgh, Pa. The council also recommended that inasmuch as by the election of the foregoing persons the active list of membership was filled up, the wording of the constitution be altered to admit of an active membership of 150 instead of the present number of 125. This recommendation was favorably received and will be acted upon by the society at the next annual meeting.

On the evening of the twenty-ninth the society was the guest of the Boston Bacteriological Club at a "smoker" held in the rooms of the Technology Union, where the members thoroughly enjoyed themselves in an informal manner.

The program, as shown by the following titles and abstracts, was carried out and evoked much

interest and discussion, making the meeting one of the most successful that the society has yet experienced:

Some Observations on the Immune Body: J. J. KINYOUN, Health Department, Washington, D. C. (President's address.)

The president in the address delivered before the Society of American Bacteriologists gave a résumé of his observations on the several immune bodies in connection with the production of anti-sera and other substances associated with the phenomena of immunity. He claims that a distinction should be drawn between the specific anti-bodies as for example, the anti-toxin of diphtheria or of tetanus and other bodies which are also present in such sera. The claim is advanced that there is present in all such sera containing specific anti-bodies, others which may be termed common immune bodies. These have the property of increasing the resistance of the cells against many substances which are harmful to them and are of diverse origin. These common immune bodies are intimately associated with the leucocyte and it is believed that the leucocyte gives them origin. The statement is also made that the curative value of all anti-bacterial sera is due not so much to the specific anti-bodies, but to the common immune bodies which are always present.

An Improved Method of Employing "Antiformin" and Ligroin, in the Examination of Sputum, etc., for the Tubercle Bacilli: J. J. KINYOUN, Health Department, Washington, D. C.

The improvement of the method is in the simplification of the process both as to time and in manipulation. In the case of sputum, a small quantity of the "antiformin" forms one to three cubic centimeters, and about one cubic centimeter of ligroin (spec. grav. 0.715 to 0.720) is added at the same time. The sputum is placed in a shaker and shaken for about fifteen minutes, at which time the cellular contents and mucus are dissolved together with a greater proportion of the bacteria. A small quantity of this is placed in a centrifuge tube and spun at moderate speed for a minute or so to bring the ligroin to the top. The layer of saponified material lying at the juncture of the sputum and ligroin will contain nearly, if not all, the tubercle bacilli. Tissues can also be examined in the same way; small bits of the suspected tissue are placed in the antiformin together with ligroin and shaken in the same manner as for sputum, then centrifugalized and examined. This method is also well adapted for the examination of feces. The main advantage is the saving of time.

On the Production of Agglutinating Sera for Diagnostic Purposes: J. J. KINYOUN, Health Department, Washington, D. C.

The writer states that there is always an element of uncertainty in the production of anti-sera when the smaller laboratory animals are employed. And particularly is this true with the rabbit and guinea pig. It occurred to him to use medium-sized pigs (or shoats) for this purpose. These animals were found to be well adapted for the purpose as they withstood large quantities of living cultures of *B. typhoid*, *B. paratyphoid*, "*a*" and "*b*" and *B. coli* without the least discomfort. After two or three injections of any of these organisms above referred to, an agglutinating serum was obtained which reacted in high dilutions. The bleeding was from the tail; the quantity taken varied as to the size not less than 100 c.c. nor more than 400 c.c. at a bleeding. The animals are easy to handle, their maintenance is as cheap as smaller animals, and, moreover, they can always be depended upon not to die just before you complete the immunization.

Some Observations on the Fermentation of Silage: W. M. ESTEN, Storrs Agricultural Experiment Station.

The prevailing opinion of investigators in silage fermentation is that respiration and enzymes are the real agents in the process. These conclusions are maintained on account of finding high temperatures in fermenting silage and the forming of ensilage in the presence of chloroform and so forth. High temperatures are found in silage only when the surface is exposed to the air and where an alkaline fermentation is in progress, or when the per cent. of moisture is relatively low. Inside the silo, where acids are produced to preserve the silage, no high temperatures are found. When silage is formed by sterilizing with chloroform and so forth no acid is produced.

In cutting corn for ensilage each piece is covered with a film of sweet juice. In the subsequent filling of the silo the several tons of pressure forces out more juice, so that every piece and fragment of the silage is saturated and covered with a sugar fermentable substance, mostly dextrose. As is well known, all sweet fruit and plant juices undergo two types of fermentation, acid or alcoholic, and in some cases both occur together. The most common change of sugar to acid is by

lactic-acid bacteria. Some fruit juices, like apple cider, contain so much acid that nearly all kinds of bacteria are unable to grow in them. Apple juice contains about .72 per cent. of total acid. Corn juice has about .25 per cent. of unknown acid and some gallic acid (?). In corn juice lactic acid bacteria grow profusely till about .35 to .45 per cent. of lactic acid is formed, when they cease to grow. But yeasts are tolerant to much larger amounts of acid and therefore continue to grow in the corn juice till practically all the sugar is used up. The alcohol formed is mostly changed into acetic acid. In fresh silage large numbers of yeasts and acid bacteria are found. During the first twelve days of fermentation nearly all of the biochemical changes are completed. The maximum growth of acid bacteria is on the fourth day and the maximum growth of yeasts is on the twelfth day. The highest temperature of 29° C. was noted in the first 36 hours. The samples were taken from a hole in the silo five feet from the bottom, and from one to two feet from the edge.

Further Studies in the Acidity of Fresh Milk: W. M. Esten, Storrs Agricultural Experiment Station.

The entire range of variation of the acidity of the milk in a year for a herd of cows numbering more than twenty-five was from .155 to .187 per cent. The law of variation is that the acid of the milk varies inversely as the temperature. Approximately on the first of February the milk of all the cows is at its highest point of acidity. On the first of August it is at its lowest point of acidity. These two dates include the coldest and warmest periods of the year.

The variation during a lactation period proves to be quite remarkable. An acidity of .48 per cent. has been found at the first milking. In from two to three days it falls to about .25 per cent. from this figure, then gradually in about three weeks to the normal, near .17 per cent., which continues until about three weeks before the end of the lactation period, when, at the last milking, it falls to .12 or .13 per cent. The high acidity at the beginning is explained by the fact that the ash and salts are very much in excess of the normal amount. Some of these are probably calcium salts which are necessary for bone production in the young animal.

The quality of the milk varies as the acidity, so that winter milk has more food value than in summer and a higher price in winter is justified by this fact.

The acidity has an important bearing in the inspection of milk. A dairy selling Jersey milk with 5 per cent. of butter fat will sometimes show an acidity of .20 per cent when fresh, and does not then contain a particle of lactic acid. Under these conditions the milk should not be condemned for high acidity, but rather recommended for the high acidity which indicates a high quality. It is therefore requisite that milk inspectors be capable of judging the high acidity of milk which indicates high quality and value, from high acidity caused by growth of acid organisms which produce lactic acid in milk of any quality.

Bacteriological Methods in the Oyster Survey of Virginia: Meade Ferguson, Laboratories of State Board of Health of Virginia. (Read by title.)

Methods of Testing Shellfish for Pollution: Stephen DeM. Gage, Massachusetts State Board of Health, Experiment Station, Lawrence, Mass.

The methods for testing shellfish for pollution in Massachusetts have been devised to facilitate the routine handling of a large number of samples in the easiest and most accurate way.

Collection of Samples.—Twelve to fifteen shellfish are collected from each sampling station, in wide-mouth spring-top glass jars. The sampling stations are distributed well over the area from which shellfish are gathered, and samples of sea water are collected from each station in addition to the shellfish samples.

Transportation of Samples.—Shellfish samples should be delivered at the laboratory within twenty-four hours after collection. Packing samples in ice is probably unnecessary, except during very hot weather.

Technic of Testing.—The individual shellfish is washed with sterile water, opened with a sterile oyster knife and a portion of the shell water transferred to a fermentation tube. The body of the shellfish is then removed from the shell, washed with sterile water, opened with a sterile scalpel and a portion of the alimentary canal transferred to another fermentation tube. Ten individual shellfish from each sampling station are tested in this manner.

B. coli Methods.—Dextrose pepton water is used in the fermentation tubes. The incubation of these tubes and the isolation and confirmation of *B. coli* are in accordance with the standard methods used in water analysis. No systematic search is made for the sewage streptococcus, but

if its presence is noted either on the plates or on the agar streaks, this is recorded.

Interpretation.—Tests of a single shellfish from any location have little diagnostic value. When a sufficient number of shellfish have been tested, the absence of *B. coli*, or of positive fermentations followed by an overgrowth of sewage streptococcus in 80 per cent. of the samples tested, indicates that the location is reasonably free from pollution. If 50 per cent. or more of shellfish from a location show *B. coli*, or fermentation overgrown by sewage streptococcus, the location is dangerously polluted. Between these limits, the interpretation is a question of degree of pollution, based on individual judgment, into which analyses of the sea water from the same source, and a sanitary inspection of the source must enter.

Some Peculiarities in the Counts of Bacteria at 20° C. and at 40° C. from Waters Treated with Disinfectants: STEPHEN DEM. GAGE, Massachusetts State Board of Health, Experiment Station, Lawrence, Mass.

For some years we have been making counts of the bacteria at 40° C. in addition to the usual count at 20° C., and have found that with natural waters and the effluents from good water filters there is an approximately constant ratio between the counts at the two temperatures. For example, effluents from good water filters, and surface and ground waters used as public water supplies in Massachusetts, usually contain less than 100 bacteria per cubic centimeter according to the 20° C., less than 10 per cubic centimeter, as shown by the 40° count, and about half of the latter will produce red colonies on litmus lactose agar.

When dealing with waters, etc., which have been treated with certain disinfectants such as bleaching powder, whose efficiency is produced by oxidation, we have frequently found that while the numbers of bacteria determined at 20° C. might be reduced to less than 100 per cubic centimeter by a small amount of disinfectant, frequently there would be no corresponding decrease in the 40° count, and that considerably more disinfectant must be used to make the 40° count conform to the standard of the good waters, as previously stated.

Furthermore, in a great many instances the 40° count on disinfected waters was as high or higher than the 20° count. This phenomenon has occasionally been observed with natural waters and sewages, but an analysis of the records of many thousand samples shows that the percentage of such samples is not over five per cent. On the other hand, 20 to 25 per cent. of samples of water and 50 to 70 per cent. of samples of sewage and effluents from contact and trickling filters, after treatment with bleaching powder, showed higher counts at 40° than at 20° C. This abnormally high 40° count is seldom found when the 20° count is high, but when the latter count is below 100, these peculiar results are frequent.

These abnormal ratios with disinfected waters are not peculiar to Massachusetts, but have also been noticed elsewhere where bleach disinfection has been tried. In many instances, however, such results appeared to be so erratic that they were considered to be abnormal and were thrown out, and we so considered them at first. When we found that they occurred with a frequency of 20 to 70 per cent., however, we did not feel justified in calling them abnormal or in throwing them out.

It can be stated definitely that this phenomenon of abnormal ratios is not due to spores. A careful study of this point has been made, and the ratio between total colonies and spore formers at both 20° and 40° has been proved to be practically the same before and after disinfection.

Diphtheria Bacillus Carriers in the Public Schools: F. H. SLACK, B. L. ARMS, E. M. WADE and W. S. BLANCHARD, of the Bacteriological Laboratory of the Boston Board of Health.

This paper presents the details and results of an experiment undertaken at the beginning of the school year in the Brighton District of Boston, Mass.

The pupils in this district number over 4,000 and two cultures were taken from each during two successive weeks. All microscopic examinations were made in the bacteriological laboratory of the Boston Board of Health by the regular corps of workers.

Positive results were reported only on those cultures showing the A, C or D types of organisms (Wesbrook).

On the first day, 1,287 cultures were examined; the second, 1,131; the third, 1,029; the fourth, 699—a total of 4,146, and of these 55 or 1.33 per cent. were positive.

These cases were for the most part removed from school.

The second round the following week gave 1,275 cultures the first day; 1,113 the second; 1,029 the third, and 670 the fourth—a total of 4,081, of which 38, or .93 per cent., were positive.

Details concerning these cases and a five-year chart of clinical cases in the district are given.

The following conclusions are reached:

1. That at least 1 per cent. of all healthy school children are carriers of morphologically typical diphtheria bacilli (Wesbrook's A, C, D types).

2. That such bacilli are communicable from one to another and the condition is usually a transient one.

3. That the organisms are ordinarily of little or no virulence.

4. That while it is possible, by passing through a susceptible individual, their virulence might be raised to cause the disease, this is not a frequent occurrence.

5. That the disease diphtheria is kept alive in a community rather by virulent organisms in immune persons than by these non-virulent bacilli.

6. That where *virulent* diphtheria bacilli are present as shown by outbreaks of the disease, cultural tests of all contacts and isolation of those showing positive cultures is a duty owed to the community.

7. Where the *disease* does not exist, isolation of carriers of probable *non-virulent* bacilli is of no proven benefit, and is a costly and laborious procedure entailing much unnecessary hardship on innocent and probably harmless parties.

8. The attempt to control diphtheria in a city by a round of cultures from all school children at the beginning of the school year does not seem encouraging from this series of tests.

9. The proposition to stamp diphtheria out of a city by cultural tests of all the inhabitants and isolation of all carriers is impossible from any practical standpoint.

The Virulence of Old Cultures and Subcultures of B. mallei: B. L. ARMS, M.D., Assistant Director of the Bacteriological Laboratory of the Boston Board of Health.

From work done at the Boston board of health laboratory the following conclusions are drawn:

1. That in glycerine broth, *B. mallei* live and retain their virulence for at least two monthe, even when kept at body temperature.

2. That a culture of *B. mallei* may be virulent after growing on potato for at least a month.

3. That some stains of *B. mallei* retain their virulence through a great many subcultures on artificial media.

How shall the Value of Disinfectants be Determined? E. M. HOUGHTON, Detroit, Mich.

Some Observations on the Wassermann Reaction: LAWRENCE T. CLARK, Detroit, Mich.

Departures from the principles upon which the original Wassermann method for the serum diagnosis of syphilis is based are fraught with the dangers attending unreliable and, in many cases, entirely erroneous results. In making the test a thorough knowledge of the strength and keeping qualities of the various factors entering into it is very essential. Such facts, enumerated in the conclusions, make it possible to diagnose a high percentage of doubtful cases with a considerable degree of accuracy.

Conclusions.—The complement content of fresh guinea-pig serum varies materially with different pigs.

More uniform and accurate results are obtained when the guinea-pig serum is standardized to known normal and syphilitic sera before doubtful samples are tested.

Hemolytic serum kept at uniform low temperature retains its activity for a relatively long time, although it loses some of its original strength and needs restandardizing from time to time.

Suspensions of thoroughly washed red blood corpuscles (ram) kept at 1.6° C. have been used up to fourteen days after drawing with good results.

Samples of serum inactivated (56° C. one half hour) and kept free from contamination, remain unchanged for several days. This enables one to store samples and run several at one operation.

Practical tests made with properly standardized reagents gave 95 per cent. and 93½ per cent. accurate results in known and doubtful cases, respectively.

Negative reactions were obtained after vigorous specific treatment in eight cases which gave positive reactions before treatment. A future publication will deal with this phase more extensively.

It would seem to be indicated by results from the limited number of cases tested that the complement fixation reaction, when carefully carried out and thoroughly controlled, is a reliable means for diagnosing the doubtful case.

The Usefulness of Curves in the Interpretation of Biochemical Processes: OTTO RAHN, Michigan Agricultural College.

If a curve of a biochemical process is plotted, taking as abscissa the time elapsed and as ordinate the total amounts of compounds produced, the shape of this curve will in many instances indicate the nature of the change taking place. In a purely chemical or enzymatic change, the active mass does not increase, and therefore the rapidity of the process measured by the angle of elevation of the curve does not increase. (Under enzyme is understood a chemical compound, unable to multiply.) The curve changes with the

time, becoming more and more parallel to the base line. If we are dealing with changes caused by microorganisms, the active mass is increasing as long as microorganisms increase, and consequently the velocity of the process, or the angle of elevation, will rise as long as the increase continues. This elevation of the curve is characteristic for compounds produced by any multiplying organism. From the time the increase ceases, we are dealing with a purely enzymatic curve.

The exact plotting of the curve allows us to make fairly accurate statements about the multiplication and the duration of the increase of bacteria, even if they can not be counted by our present methods. The point of inflection of a curve shows the moment when the organisms producing the substance under study reach their maximum number and can be studied with the greatest convenience.

In some instances, the point of inflection is changed to a straight line, indicating a very resistant strain of bacteria; this seems to take place especially in poor media, as soil extracts. A few experiments indicate that poorly nourished bacteria are able to produce a larger amount of fermentation products than well-nourished bacteria, though they need a much longer time to accomplish it.

The Society Card as a Basis for Classifying the Bacteria producing Soft Rot in Vegetables: H. A. HARDING and W. J. MORSE, New York Agricultural Experiment Station.

This group includes *B. carotovorus* Jones, *B. aroideæ* Townsend, *B. omnivorus* van Hall, *B. oleraceæ* Harrison and some other described forms.

A comparison on the basis of the society card brings out the fact that these described cultures are identical in all cultural characters except the results from the fermentation tube.

Extended study of this point indicates that this difference is more apparent than real, since the normal gas-forming ability of this group lies so near the amount required to saturate the fermentation tube that the appearance of visible gas varies with the fermentative vigor of the particular culture.

These results indicate that in cases where the fermentative ability of a culture is weak there is need of a more accurate instrument than the fermentation tube for accurately detecting gas formation.

(Data to appear as New York Agricultural Experiment Station Technical Bulletin 11, 1909.)

Does the Group Number on the Society Card Carry the Classification far enough to Break up the Species? H. A. HARDING, New York Agricultural Experiment Station.

This point was tested with approximately fifty strains of *P. campestris* (Pam.) Smith. This species was chosen because it is a well-known, chromogenic, plant-pathogen in which the limits of the species can be determined with the minimum chance of error.

Some of the tested strains were freshly isolated from the host while others had been cultivated in various laboratories for many months. The larger part of these cultures were revivified just previous to being tested and were tested on standard media. In some cases these precautions were purposely omitted. Independent observations were made in some cases by three different workers and media prepared by three different persons was used.

With the exception of the reduction of nitrate there was no variation in the group number as determined from these cultures.

The variation in nitrate reduction, as determined by the official method for nitrite, was apparent rather than real since it was not shown by the nitrite test with the starch, KI, H_2SO_4 test. The faint reactions obtained with the official test were undoubtedly due to absorbed nitrite. Nitrite is not absorbed equally by all tubes and a large number of check tubes must be held to insure accurate comparisons in faint reactions.

A New and Improved Method of Enumerating Air Bacteria: LEO F. RETTGER, Yale University.

Studies on Bacterial Mutation: LEO F. RETTGER, Yale University.

A Comparative Study of Intestinal Streptococci from the Horse, the Cow and Man: C.-E. A. WINSLOW and G. T. PALMER, Massachusetts Institute of Technology.

Andrewes and Horder's statistical study of the streptococci has for the first time made it possible to classify the principal types of this complex group in a fairly satisfactory manner. One of the most interesting points about Andrewes and Horder's classification, and the earlier observations of Gordon and Houston on which it was founded, was the apparent difference between streptococci from the intestines of the horse, the cow and man. In the present investigation we have tested this point by isolating one hundred strains of streptococci from fæces of each of the three animals; we have cultivated them in broth containing four different fermentable media (dextrose, lactose,

raffinose and mannite), and determined by titration the amount of acidity produced by each strain in each medium. An examination of the results obtained confirms and harmonizes the work of the English observers in all particulars. The commonest streptococci in human fæces are *S. mitis* (acidifying dextrose and lactose), *S. fœcalis* (dextrose, lactose and mannit) and *S. equinus* (dextrose alone). In the fæces of the cow *S. equinus* and *S. mitis* are present; but *S. fœcalis* is absent and a form rare in human fæces, *S. salivarius* (dextrose, lactose and raffinose), is fairly abundant.. In the fæces of the horse practically all the streptococci present are of the *S. equinus* type. (Full paper, *Journal of Infectious Diseases*, VII., 1.)

The Determination of the Number of Leucocytes in Milk by a Direct Method: S. C. Prescott and R. S. Breed, Boston, Mass.

The methods in general use for determining the number of leucocytes present in milk are all based on the use of the centrifuge. The assumption is that all but a small fraction of the leucocytes are precipitated and also that this fraction is a fairly constant proportion of the whole and can safely be neglected. An investigation carried on in the Boston Biochemical Laboratory during the past summer has shown both of these assumptions to be incorrect. By the use of a new method, it has been found that the distribution of the leucocytes in a given sample of milk after centrifuging varies greatly in different samples of milk, although their distribution is approximately the same in different samples of the same milk. Usually more than half are present in the cream, one fourth or less in the precipitated slime, and the remainder in the skim milk.

The variation in position of leucocytes in different samples is apparently due to the variable percentages of cream present. The distribution of the leucocytes in a centrifuged sample corresponds closely to the previously known distribution of bacteria in similar samples.

The new method by which these facts have been ascertained is as follows: a measured drop (.01 c.c.) of milk to be examined is spread evenly over a measured area (1 sq. cm.) on a glass slide, dried with gentle heat, the fat dissolved out with xylol, fixed with alcohol for a few minutes, the slide again dried and over-stained with methylene blue and partially decolored with alcohol. The number of leucocytes present is then determined by examination with the microscope. Results done in duplicate show a small percentage variation proving that the practical error is not a large one.

A series of tests of milk show that much larger numbers of leucocytes are normally present in milk than has been supposed. The average number of leucocytes present in the samples examined is approximately 1,500,000 per cubic centimeter, while numbers less than 100,000 per c.c. are uncommon.

The Bacteriology of Condensed and Evaporated Milks: S. C. Prescott and R. N. Hoyt, Massachusetts Institute of Technology.

Some Problems of Sanitary Milk Production: P. G. Heinemann, A. B. Luckhardt and A. C. Hicks, The University of Chicago.

A series of experiments was made during the month of September at a sanitary dairy to throw light on the following points: (1) the bacterial content of separator milk and cream, (2) the value of narrow top pails with and without strainers, (3) the bacterial content of milk after straining through layers of absorbent cotton, (4) a study of body cells in separator slime and an attempt at classification.

It was found that the bacterial content of the separator cream was very small, the average of 48 tests being 132 bacteria per cubic centimeter of 40 per cent. separator cream. The separator milk in the same number of tests contained 2,130 bacteria per cubic centimeter and the original milk contained 738 bacteria per cubic centimeter. We conclude from these experiments that the action of the separator tends to break up clumps, chains and imperfectly divided forms so as to increase the colony count.

The experiments with the narrow top pail with and without strainer showed that the count was 620 bacteria per cubic centimeter with the strainer and 674 without the strainer. These figures are the averages of 108 tests. The small difference in favor of the strainer may possibly be due to experimental error and of little significance. Still we think that the strainer should not be omitted, since the milk needs straining at some point or other of production to remove foreign material which is bound to gain access even in the most carefully managed dairies.

As a result of 240 consecutive tests we conclude that straining milk through thick layers of absorbent cotton, as is customary in many dairies, is decidedly disadvantageous. The force of the milk being poured on top of the strainer seems to break up bacterial aggregates so as to increase the colony count in the strained milk.

Our study of the body cells in the separator slime has led to the following conclusions:

1. Polymorphonuclear leucocytes of the neurophile type, large mononuclear leucocytes, and small lymphocytes appear normally in the separator slime of the milk of healthy cows, and as far as we can see they bear no relation to the number of microorganisms present, including streptococci.

2. Eosinophiles may occur in the slime of the separator. The cause and significance of their presence remains problematical.

3. The white corpuscles in milk of normal and diseased cows, and in the blood of the same animals, ought to be studied, differentiated and classified. Such a study will put the subject of leucocytes in milk on a more exact scientific basis than heretofore, and further our knowledge on the significance of the relative number of the various corpuscles in milk in normal and diseased conditions of the cow in general, and in pathological processes of the mammary glands and the udder in particular.

The details of our experiments and a critical discussion of previous work will appear in the January number of the *Journal of Infectious Diseases*.

A Bacterial Disease of Alfalfa caused by Pseudomonas medicaginis (Sackett) n. sp.: WALTER G. SACKETT, Agricultural Experiment Station of Colorado.

The disease has been known in Colorado since 1904, where, in some localities, it has caused the loss of practically 80 per cent. of the first cutting.

In the earliest stages, the stems have a yellowish, olive-green color and appear watery and semi-transparent; soon the color changes to an amber, due to the appearance and subsequent drying of a thick, clear exudate. This dried excretion gives the stem a shiny, varnished appearance, and a slightly rough feel to the touch. These stems blacken in six to eight weeks, become very brittle and are easily broken, which fact makes it almost impossible to handle the crop without an immense amount of shattering.

So far as our observations go, the disease is confined principally to the stem and lower leaves; it appears to run its course with the first cutting, and those plants which have sufficient vitality throw out a good growth for the second and third cuttings.

The disease has been shown to be due to a bacterium which lives in the soil, presumably, and this infected soil enters the plants through cracks in the epidermis which are caused by freezing.

Brief characterization: The causal organism is a short rod with rounded ends, size $1.2 \times .7\ \mu$, actively motile by 1–4 bipolar flagella, non-spore-forming and to which the writer has given the name *Pseudomonas medicaginis*, n. sp. The organism forms filament but no capsules; Gram negative. Surface pellicle in broth; shining grayish white on agar, fluorescent green after three days; gelatin colonies round, gelatin stab-surface growth only, no liquefaction; potato discolored, moderate growth, orange yellow, starch not destroyed; no growth 37.5° C.; no growth in Cohn's solution; growth in Uschinsky's solution. No liquefaction; rennet curd 40 days, no peptonization 25 days; no indol or hydrogen sulphide; nitrates not reduced; ammonia from peptone and asparagin; fluorescent. Habitat—soil. Pathogenic for alfalfa. Classification, Ps. 212.3332133.

This paper, in full, is now in press as a bulletin of the Colorado Agricultural Experiment Station.

A Comparative Test of Several Synthetic Media for the Isolation of B. coli: H. W. LYALL, Brown University.

The three media studied were Harrison and Vanderleck's esculin medium,[1] Dolt's asparagin medium[2] and Dolt's malic acid medium.[3]

The total count, the number of red or black colonies, and the per cent. of these which proved to be *B. coli* were determined.

The results are given in the following table:

Medium.	Source of Sample	Total Count	Average Number of Red or Black Colonies	Per cent. of Colon
Standard. Lactose agar.	A B	527 84	20 2	50
Esculin.	A B	105 30	26 2	64
Asparagin.	A B	90 24	7 1	88
Malic acid.	A B	23 7	5 2	94

A = Pettaconsett intake—Pawtuxet River.

B = East Providence intake—Ten Mile River.

The conclusions drawn were that the esculin medium is of about the same value as the standard litmus lactose agar over which it has no advantages, the asparagin agar gives a much

[1] *C. f. B.*, I., Orig. 51, 1909, 607.

[2] *Jour. Inf. Dis.*, 5, 1908, 616.

[3] *Ibid.*

higher percentage of colon colonies than either the standard litmus lactose agar or the esculin medium, and is a very favorable medium for colon isolation, the malic acid agar gives a still higher percentage of colon colonies, combined with a very low total count, and is a very satisfactory medium for colon isolation when only the active forms indicative of recent pollution are desired.

Studies in Soil Bacteriology, IV.: The Inhibition of Nitrification by Organic Matter, Compared in Soils and in Solutions: F. L. Stevens and W. A. Withers, assisted by P. L. Gainey, J. K. Plummer and F. W. Sherwood, North Carolina College of Agriculture and Mechanic Arts.

In experiments regarding nitrification it was demonstrated that:

In Liquid Medium

Peptone 0.8 per cent. inhibited at 4 weeks.

Cottonseed meal, nitrogen equivalent, 0.1 per cent. inhibited at 4 weeks.

Cottonseed meal, nitrogen equivalent, 0.1 per cent. inhibited at 16 weeks.

Peptone 0.8 per cent. inhibited at 16 weeks.

In Liquid Medium absorbed by Soil

Peptone 1.25 per cent. retarded at 4 weeks.

Peptone 5 per cent. inhibited at 4 weeks.

Peptone 5 per cent. did not retard at 16 weeks.

Cottonseed meal, nitrogen equivalent, 0.4 per cent. retarded at 4 weeks.

Cottonseed meal, nitrogen equivalent, 0.5 per cent. retarded at 16 weeks.

Cottonseed meal, nitrogen equivalent, 0.1 per cent. did not retard at 4 weeks.

Cow manure in quantities equivalent to 1, 5, 10, 20, 30, 40, 80, 160 tons per acre in 2-week, 8-week and 12-week periods, did not retard nitrification in soil at 8 weeks but rather favored it.

Nitrification occurred in pure cow manure at 8 weeks and at 12 weeks.

A Simple Low-temperature Incubator: Karl F. Kellerman, Bureau of Plant Industry, Washington, D. C.

During the winter of 1905 the writer found it necessary to improvise a low-temperature incubator, and since that time has had similar ones in almost constant operation. The incubator is fundamentally a four-compartment refrigerator carrying ice in the upper right-hand compartment and a heater, consisting of a single incandescent electric-light globe and a thermo-regulator, in the lower left-hand compartment. The thermo-regulator may be operated on a separate circuit using a storage battery or Edison-Leland cell, or from a shunt circuit from the main feed wire. Such incubators may be installed readily and may be used for either temporary or permanent purposes.

Flagella Staining of Pseudomonas radicicola (B.) Moore: Karl F. Kellerman, Bureau of Plant Industry, Washington, D. C.

Staining unfixed smears of *Pseudomonas radicicola* with saturated alcoholic stains according to the method of Edwards and Barlow has occasionally given the figures described by these authors as indicating the polar flagella or "giant whips." I have been able to duplicate these appearances almost exactly by mixing bacteria which had no polar flagella with artificial slime or gum and preparing and staining the slides according to the method of Edwards and Barlow. Therefore, while this method of staining may have a diagnostic value for the peculiar slime secreted by *Pseudomonas radicicola*, I do not believe that the flagella themselves are indicated.

Nitrification Studies in Nevada and Utah: Karl F. Kellerman, Bureau of Plant Industry, Washington, D. C.

In the arid and semi-arid regions of the west there are two areas which in many ways should be comparable; these areas are the beds of the prehistoric Lake Bonneville in Utah and Lake La Hontan in Nevada. The former, containing the Mormon settlements, has long been famous for the crop-producing power of its soil; the latter has furnished some valuable farms to early ranchers, and recently considerable areas have been brought under irrigation as the Truckee-Carson project.

During the past year nitrification studies have been carried on in Utah by Mr. I. G. McBeth and in Nevada by Mr. E. R. Allen. These studies have indicated that nitrification proceeds in Utah soils following the same general rates of activity in the different layers that occur in eastern soils, nitrate formation decreasing very rapidly below the surface, although it persists to much greater depth than has usually been described. Azotobacter is very frequent and occurs in appreciable numbers even as far below the surface as the tenth foot. In the Nevada soils nitrification is very erratic, the surface layers in many cases nitrifying much less rapidly than deeper layers, while some regions seem to lack the nitrifying flora almost completely. The deficiency in nitrifying bacteria seems correlated with poor crop production in many cases, although the prevalence of alkali is also a source of crop injury. When not present in excessive quantities the white

alkali does not seem to be the controlling element in the nitrification processes, and judging by the innocuous action of gypsum it seems evident that in these regions black alkali is not sufficiently abundant to be an important factor. In the deeper layers of the most unproductive soils a peculiar fungus is very prevalent and is probably associated with the failure of this soil to produce crops.

Desiccated Culture Media: W. D. FROST, University of Wisconsin.

In order to overcome the generally recognized faults of bacterial culture media, such as variation in the composition of small batches, time consumed in preparation, rapidity with which it deteriorates, and its unavailability in small institutions or private practise, the preparation of culture media in large batches in establishments especially equipped for it and then desiccated, is suggested.

The author's work on this problem, covering nearly a decade of time, is considered and samples are submitted.

There is, apparently, no reason why the different culture media can not be put upon the market in a form which requires merely the addition of water and sterilization to make it ready for use. Not only the ordinary, but probably most of the special media, can be prepared in this way and could be put up, where desired, in the form of tablets, these to be of such a size that they could be put directly into test tubes, and when the proper amount of water is added they would be ready for sterilization and use.

Laboratory Desks for Students in Bacteriology: W. D. FROST, University of Wisconsin.

A laboratory desk is described for use in student laboratories for which it is claimed that the maximum number of students can be accommodated in given quarters with, probably, the minimum of confusion. The desk is similar to those used in chemistry, without the shelf above it. It is provided with a wide trough running the full length, which serves as a sink and over which gas hot plates are placed to be used in cooking and sterilization. Each place is provided with three lockers which can be used by as many different students. The reagent shelves are provided for and a shelf for rough weighing at one end, and at the other end the hot-air sterilizer and autoclave. Microscopical work can be done at each place by using artificial light, or at small window desks, provided for separately.

An Inexpensive Incubator Room: W. D. FROST, University of Wisconsin.

A small room is used and maintained at a satisfactorily constant temperature without other change than the attachment to the steam radiator of a thermo-regulator designed for residences. The cost was about thirty dollars, and, with proper shelving, the room will accommodate several hundred students. An arrangement of lockers is also suggested which largely removes the temptation of students to appropriate cultures not belonging to them.

The Absolute Relation of B. coli to Oxygen: F. G. KEYES, Brown University.

The absolute relation of gaseous oxygen to the growth and gas production of *B. coli* promises to be somewhat complicated.

In a study of the absolute gas production of *B. coli* in vacuo,[4] it was found that the gas evolved from a 1 per cent. asparagin, 0.2 per cent. disodium phosphate, 1 per cent. dextrose medium began to fall off very decidedly after 115 hours, but the gas evolved was constant in composition.

In the presence of pure oxygen, no other gas being present, it is found that the rate of evolution of gas is much smaller, but gas production continues for a much greater length of time. The composition of the evolved gas is different when the organism is grown in the presence of oxygen from what it is in vacuo. The composition of the gas depends to a certain extent upon whether the medium is neutralized or not. Some oxygen is absorbed by the growth of the organism in the medium.

The tables below summarize the results of the experiments.

The Absolute Gas Production of B. Typhosus: L. J. GILLESPIE, Brown University.

While attempts were being made to find a synthetic medium suitable for the growth of *B. typhosus* and such as to facilitate a comparison with the gas production of *B. coli*, preliminary experiments were made using a medium containing Witte's peptone. *B. typhosus* was grown on a neutral medium containing 1 per cent. dextrose and 1 per cent. peptone; and the gas evolved, obtained by the procedure given by Dr. F. G. Keyes, was analyzed. The amount of gas found was so small that analyses with the ordinary 100 c.cm. gas burette and gas pipettes were carried out with difficulty. The analyses indicated, however, the following results for 48 hours' growth:

[4] *Jour. Med. Res.*, 16, 1909, 69.

ABSOLUTE GAS PRODUCTION

In Vacuo (Medium not neutralized)					In Oxygen (Medium neutralized with NaOH)					
Hours in Incubator	Total Per Cent. of Gas	Composition of Gas			Hours in Incubator	Total Per Cent. of Gas	Composition of Gas			Oxygen Absorbed in c.cm.
		CO_2	H_2	N_2			CO_2	H_2	N_2	Dry 20° C. 760 mm.
24	26.7	63.23	36.61	0.15	25	15.17	98.83	0.18	0.99	1.57
48	45.6	63.27	36.05	0.37	127	18.56	97.90	0.52	1.58	2.55
115	99.9	63.49	35.81	0.70	167	27.18	98.21	1.06	0.73	5.52

Total gas per 100 c.cm. medium	1.4 c.cm.
CO_2	92%
H_2	3%
N_2 (by difference)	5%

By means, however, of an improved gas analysis apparatus devised by Dr. Keyes it was found possible to analyze accurately such small amounts. The results for 15 days' growth were as follows:

	Exper. I.	Exper. II.
Total gas obtained ...	3.49 c.cm.	5.89 c.cm.
Total gas per 100 c.cm. medium	2.55 c.cm.	2.32 c.cm.
CO_2	93.25%	97.10%
H_2	2.03%	2.12%
N_2 (by measurement)	4.44%	.77%
	99.72%	99.99%

Experiment II. probably approaches nearest the truth, as the leakage of only a trace of air into the bulb during incubation would easily suffice to falsify the figure for nitrogen.

Substitutes for Löffler's Bloodserum for the Diagnosis of Diphtheria: W. W. BROWNE, Brown University.

Attempts were made to grow the diphtheria bacillus on Hadley's medium,[5] solidified with 5 per cent. agar. Growth on this medium was atypical. Albumen was then substituted for the glycocoll of Hadley's medium, but on sterilization the albumen was coagulated as a flocculent precipitate through the medium. The growth was scanty. Attention was now turned to egg as a source of albumen. Egg was mixed with dextrose broth in the ratio of 1 part of broth to 3 of egg and coagulated. The medium was hard and firm. The slow growth of the bacillus on this medium would prevent its use in the diagnosis of diphtheria.

Alkaline albuminate was then substituted for the albumen. Although the albumen was not coagulated by heat, nevertheless, it was precipitated by the acid produced by the bacillus. The growth on this medium was satisfactory, but the precipitation of the albumen prevented ready diagnosis. Acid albumen, on the other hand, showed scanty growth.

Next, a 6 per cent. solution of commercial albumen was mixed with dextrose broth in the ratio of 1 part of broth to 3 of albumen. This medium when coagulated presented a hard firm surface. The bacillus seemed to grow well upon it and diagnosis from throat cultures was fairly easy. While this medium does not seem to be a perfect substitute for the Löffler's serum, yet, in times of scarcity, it might be used to good advantage.

The Hygiene of the Swimming Pool: JOHN W. M. BUNKER, Brown University.

The swimming pool is liable to be a source of contagion if the water is used for any length of time. Cases of ear and nose affections have been traced to this source. Typhoid is apt to enter the pool and spread therefrom, and unless an abundant supply of water is available, the expense of frequent renewal is prohibitive.

Filtration is the method of purification ordinarily employed, but usually yields only partial purification, inasmuch as only a small part of the water of the pool is removed, filtered and returned to the pool. The filter at Brown University has a high efficiency and keeps the water of the pool a good color, but the bacterial content of the pool is always high.

Sterilization by heat is out of the question because of expense. Sterilization by the addition of chemicals has proved effective in the case of

[5] *Journal of Infectious Diseases*, Supp. 3, May, 1907, p. 95.

sewage and water, chlorine being especially effective.

The application of this method to swimming-pool water was tried, with the result that hypochlorite of lime in quantities sufficient to give one part available chlorine to two million of water gave efficient sterilization. The pool when so treated remained practically sterile for four days, during constant use. No odor or taste from the chemicals was noticeable. How often such treatment need be applied must vary with local conditions.

Probably for the ordinary swimming pool, if these experiments are borne out by experience, the addition of hypochlorite of lime, in the proportion of one part available chlorine to two million of water, twice a week, would insure a practically sterile pool.

A New Device for the Isolation of B. coli: W. F. WELLS, Massachusetts Institute of Technology.

A laboratory device was described which combines certain advantages of both dextrose broth and lactose bile. It consists of two Durham tubes (the first containing an enrichment medium, as dextrose, the second a selective medium, as bile) so connected by a capillary that the production of gas in No. 1 immediately causes a flow into the bile tube. As the capillary leads from the upper part of the inverted inner tube in No. 1, further increase in gas lowers the liquid below the mouth of the capillary and the flow cuts itself off.

If water containing *B. coli* is put into the dextrose tube the non-motile and aerobic bacteria remain outside the smaller inner tube, while *B. coli*, swimming continually in search of a better medium, finds its way around; so it is likely that such organisms will reach the portion about the mouth of the capillary very soon. With every advantage they multiply rapidly, and in a few hours the inverted tube contains a seething culture of vigorous *B. coli*, and gas forms quickly. The change in level causes a flow into the bile tube, just at the time of most vigorous growth, and then cuts itself off. The bile now contains an almost definite measure of thriving *B. coli*, probably in pure culture. Under these definite conditions the quantity of gas produced should be regular, and the per cent. formed in a given time after the first tube ferments significant.

The tubes are handled almost as simply as ordinary tubes. They are clamped together; a small test tube is hooked into the short leg of the capillary, while the longer legs straddle into both large tubes. They are made up and sterilized as usual, filling upon cooling.

The double medium secures the advantages of both. It does more; it preserves *B. coli* at its most favorable stage, the moment of gas production, and inoculates the bile under definite conditions with a dose of healthy organisms. It may be reasonably expected that the gas formers which are accustomed or can accustom themselves to the digestive tract will be indicated. Practical results show no unexpected error in the reasoning, and as far as they go promise an efficient test.

NORMAN MACLEOD HARRIS,
Secretary

UNIVERSITY OF CHICAGO

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 677th meeting was held on February 26, 1910, Vice-president Abbot in the chair. The following paper was read:

The Recovery and Discussion of the Earliest Magnetic Observations along the Antarctic Continent and in the Approaches to the South Magnetic Pole: Mr. G. W. LITTLEHALES, of the U. S. Hydrographic Office, Navy Department.

The results were chiefly in a chart of terrestrial magnetic lines for the epoch 1840, representing the inclination and the declination of the magnetic needle founded upon the observations of the United States exploring expedition which discovered and traversed the coast of the Antarctic continent in about 66° of south latitude between the 160th and 97th degree of longitude east of Greenwich, in the beginning of the year 1840.

The observations presented have but lately been recovered from among a part of the records of the exploring expedition of which all trace was lost for many years, and they have resulted in the portrayal of a passing state to which we could not otherwise have reascended.

Such magnetic lines from original observations made long ago have a value which increases with the lapse of years on account of their importance in elucidating the changes which time works in altering the magnetic state of the earth.

The interpretation of the results proves that American explorers were the first to point out the region of the south magnetic pole by disclosing its presence, at that epoch, as an area of considerable extent, over which the dipping needle stood vertical or nearly vertical, around a position in 68° 50′ of south latitude and in longitude 135° east of Greenwich.

Dr. W. J. Humphreys, of the U. S. Weather Bureau, then spoke informally on "Solar Disturbances and Terrestrial Temperatures."

The speaker's purpose in this paper was to bring harmoniously together, as cause and effect, some solar and terrestrial phenomena.

The sun being the source of practically all of the radiant energy we receive, any change in its surface that affects its radiation must, through the resulting modification of the energy received, also affect certain terrestrial phenomena, some of which are of vital importance.

The speaker briefly discussed the relation of the changes in the number and extent of sun-spots, flocculi and coronal streamers to such terrestrial phenomena as auroral displays, magnetic storms, temperature changes and plant growth, and pointed out how some of these relations may be explained.

The following conclusions were reached in reference to the relation of changes in sun-spots and auroral discharges to terrestrial temperatures:

1. An increase in sun-spots appears certainly to be accompanied by a decrease in terrestrial temperatures fully twenty fold that which can be accounted for by the decrease in radiation from the spot areas alone.

2. It seems nearly certain that sun-spot maxima, whatever the value at such times of the solar constant, must lead to a decrease in the ultra-violet radiation that reaches the earth, and a corresponding decrease in the production, by this method, of ozone in the upper atmosphere.

3. The increase in the auroral discharges that accompany spot maxima tend to increase the amount of ozone.

4. The change in temperature of the earth, and all its train of consequences, from spot maximum to spot minimum, is not necessarily dependent upon a change in the solar constant. It may depend largely, if not wholly, upon a change in the absorptive property of the atmosphere, caused, we believe, by a variation in the amount of ozone produced by ultra-violet radiation and by auroral discharges.

THE 678th meeting was held March 12, 1910, President Woodward presiding. Two papers were read:

Recent Work on Primary Triangulation in the Southwest: Mr. WM. BOWIE, of the Coast and Geodetic Survey.

After having completed the primary triangulation along the 98th meridian, in 1907, it was decided to extend the scheme from the 98th meridian, in central Texas, westward to the Pacific coast. This area in the southwest section of the country was badly in need of a control upon which to base surveys and engineering work.

It was originally intended that the portion of this scheme in the state of Texas should run along the Rio Grande River, from Brownsville to El Paso. This plan was abandoned owing to many difficulties which would have been encountered. The route used starts from the 98th meridian in the vicinity of Weatherford, and follows the Texas and Pacific Railroad across the state of Texas to El Paso, thence across the southern portion of New Mexico, Arizona and California to the Pacific coast triangulation in the vicinity of San Diego.

The reconnaissance for this scheme of triangulation, 1,224 miles in length, was done by a party under Mr. Bowie's direction, in four months and twenty-one days. The scheme consists of 92 primary and 38 secondary stations.

From Fort Worth to the Pecos River the land is rolling and very similar to that along the 98th meridian in Texas. From the Pecos River westward to the Pacific coast the country is mountainous with some peaks as high as 11,000 feet.

Upon the completion of the reconnaissance in February, 1908, the preparation of the stations for observations was begun at the eastern end of the line. Two seasons of observing have been completed, one of five months and three days, and one of four months and fifteen days; a total of nine months and eighteen days. The work done during those seasons was 72 primary stations occupied and completed, 12 primary azimuths observed and two base lines measured. The bases were about thirteen and fifteen kilometers in length. Six hundred and twenty-three miles of triangulation along the axis of the scheme were completed. The party doing this work was under the direction of Assistant J. S. Hill, except for two months of the first season.

The results show that the completed triangulation is of a grade equal to that of the best half of the primary triangulation previously done in this country.

Three fifty-meter nickel-steel (invar) tapes were used for measuring each base, and they gave very satisfactory results. Eight primary bases have been measured with invar tapes by the Coast and Geodetic Survey, during the past four years. These tapes hold their lengths well between standardizations. As a result of the use in the field,

no one tape has changed its length during any one season by as much as one tenth of a millimeter, or one part in 500,000.

A long step forward was made in geodesy when it was found that a primary base could be measured with steel tapes. But especial care had to be exercised with steel on account of the large coefficient of expansion, and all measurements were made at night. A second important advance was made in substituting nickel-steel tapes on account of their very small coefficient of expansion.

The observing on the Texas-California line of primary triangulation will be resumed in July of this year.

Field Observations in Iceland: Dr. F. E. WRIGHT, of the Carnegie Institution of Washington.

This paper dealt with the observations of a six-weeks' trip in Iceland by the speaker in the summer of 1909, especial attention being given to the physiographic and geologic features of the island and their influence upon the development of the country as a whole. The area of Iceland is about 40,000 square miles, and has about 6,000 miles of coast line. Its present population is about 90,000 people, largely an urban population. Iceland was settled by the Norseman in the ninth century, and for the first three hundred years thereafter it had a republican form of government. It is now a dependency of Denmark, but is largely self-governing.

Most of the houses in the country districts are built of peat, but in the towns corrugated iron is the chief material of house construction. The chief exports of Iceland are fish, eiderdown and ponies, many of the latter being used in the coal mines of England. 30,000,000 pounds of fish were exported from Iceland in 1901, most of which went to Spain.

Geologically, Iceland is a very young country, and for volcanic and glacial study it is the best region in the world, and affords the best idea of geologic forces. Iceland is a region of high seismicity and of much local magnetic disturbance.

R. L. FARIS,
Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT the 443d regular meeting of the society, held March 1, Mr. William H. Babcock presented a paper on "The Two pre-Columbian Norse Visits to America." So far no reliable evidences of Norse visits have been found on American soil, which is, however, not surprising in view of the great lapse of time, the small number of the visitors and the short duration of their sojourn. The records of the Norse visits are found in the saga of Thorfinn Karlsefin and the nearly identical saga of Eric the Red. The Flattoy book adds to the number of voyages, exaggerating many of the improbable features, and in other respects exhibiting signs of later development and corruption.

The lecturer gave an exhaustive survey and analysis of the sagas, subjecting their geographical, ethnological, historical and other data to a thorough and searching criticism. In conclusion, he said: "It seems clear that America was discovered. In addition we may be pretty safe in fixing on the neighborhood of the Bay of Fundy as the chief temporary home of Thorfinn's party in Wineland; and in following his route from Greenland thither, and later around Cape Breton into the Gulf of St. Lawrence and back to Straamfirth about as given. All else remains still open to discussion and more or less probable conjecture."

Mr. A. P. Bourland followed with an address on "The Study of Culture History in German and American Universities." The speaker gave a description of the "institutes" for the study of culture history established at some German universities. Such an institute is equipped with a series of libraries illustrating the development of the human race in all its aspects and directions, such as industry, arts and crafts, politics, jurisprudence, religion, etc. The creator of these institutes was Professor Carl Lamprecht, of Leipsic, whose conception of history is: The study of the development of human life on its economic and social sides.

AT the 444th meeting of the Anthropological Society, held March 15, Dr. Elnora C. Folkmar gave a lecture on "Education; Some Examples among Primitive Peoples." The field covered extended from Australia to Africa. The point brought out by the speaker was that among primitive peoples imitation and object lessons, as it were, take the place of methodical and theoretical teaching and training. The children unconsciously imitate the practises and doings of their elders and thus successively acquire what knowledge they have and need for life.

In the discussion Dr. J. R. Swanton called attention to the specialization in training among the Indians of the coast. Thus the Creek Indians have a kind of graded course of study, especially for the medicine men, with some sort of graduation marks by some insignia, such as a fox's skin,

the feather of a buzzard or owl. Mr. J. N. B. Hewitt pointed out that among the Iroquois education does not stop with childhood. The adults are trained in the knowledge of the tribal laws and customs and in what may be called intertribal law and diplomacy, such as the treaties and pacts entered by the tribe with other tribes, as also in the elaborate ritual connected with certain tribal events, such as the installation of new chiefs. Dr. J. W. Fewkes dwelt on education among the Hopi Indians.

I. M. Casanowicz,
Secretary

THE AMERICAN CHEMICAL SOCIETY
RHODE ISLAND SECTION

The regular meeting of the section was held February 24, 1910, at the University Club, preceded by the usual informal dinner.

Mr. C. E. Swett, of Providence, R. I., presented the paper for the evening on the subject "Field Notes from the Natural History of Silica." Mr. Swett first outlined the source and mode of formation of rocks in general and then took up the strictly silica rocks such as quartz, flint, etc. Finally he described the silica rocks containing metals, telling the chemical processes leading up to their formation, and showed a large number of specimens taken from various mines visited by him during the summer of 1909.

Albert W. Claflin,
Secretary

Providence, R. I.

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

The ninety-seventh regular meeting of the section was held at the Massachusetts Institute of Technology, Boston, on March 4.

Dr. Daniel F. Comstock, of the Massachusetts Institute of Technology, in an address on "The Present Conception as to the Constitution of Matter," briefly outlined the recent advances in the field of atomic and subatomic chemistry and physics, describing some of the brilliant experimental work that has marked these developments. There is a reasonable basis for believing that the atom has a real existence and is something more than a helpful fancy and also that the atom itself is a very complex structure.

Mr. M. C. Whitaker, of the Welsbach Co., Gloucester, N. J., described the monazite sand deposits of Carolina and Brazil, the methods of monazite mining and purification, and the preparation therefrom of the rare earths, with particular reference to the nitrates of thorium and cerium. The manufacture of gas mantles was described in some detail and there was indicated the probable lines along which improvements in mantles are likely to occur.

F. E. Gallagher

THE AMERICAN PHILOSOPHICAL SOCIETY

At the meeting of the society on March 18, the following paper was read by Dr. Jay F. Schamberg, of Philadelphia: "On Vaccination and on the Ravages of Smallpox among Royal Families." The speaker sketched the incidents of the discovery of vaccination by Jenner in 1798 and referred to the great importance of this discovery to the world. In the seventeenth and eighteenth centuries smallpox was an ever-present and death-dealing scourge, causing, it is estimated, 400,000 deaths a year in Europe. The visitations of this disease were severe in many royal families, particularly the Bourbons, the Hapsburgs, the Stuarts and the House of Orange. Since the discovery of vaccination, royalty appears to have been exempt from smallpox. Had vaccination been discovered a century earlier, the destinies of certain European countries would doubtless have been altered.

The address of April 1 before the society was delivered by David Fairchild, agricultural explorer in charge of foreign seed and plant introduction, U. S. Department of Agriculture, on "A New World for Exploration." With the origin of the term agricultural explorer it was recognized by the department that there is in the study of the botanical relatives of our cultivated plants a new world to explore. The botanical explorations of the past have been mainly for the purpose of classifying in a general way all the plant species of the world. Now that the possibilities of plant breeding are more fully recognized, the great importance of getting together the relatives of our cultivated crop plants has become very apparent. The importance was emphasized by the speaker of getting, before it is too late, the strains or races of well-recognized economic species which have been selected for centuries by cultivation in isolated mountain valleys, desert oases and oceanic islands. The rapid spread of railways and ocean travel and its accompanying seed exchange threaten to soon swamp these varieties, many of which may be of the greatest value to civilization.

SCIENCE

FRIDAY, APRIL 15, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE CHEMICAL INDUSTRIES OF AMERICA[1]

THE topic which you have done me the honor to invite me to address you upon appears on first consideration quite specific, but investigation shows that this is not quite the case. Thus we find the popular idea of a chemical industry to be one producing acids, alkalies, salts, explosives, fertilizers, dyestuffs and extracts, pigments, distillation products and elementary substances like bromine, phosphorus, sodium and others, and the officials of the U. S. Census Bureau in 1880, in fixing a classification, styled in the various censuses "chemical production" or "chemicals and allied products," adopted this popular view.

In discussing this, I have said:[2]

> A reason for the variation in the industries included at the different censuses is found in the very general and indefinite title used, for in the strictest technical sense every material thing is a chemical, and accordingly every industry in which the materials used undergo a chemical change in the process of manufacture, as in the smelting of iron from its ores or the production of leather from a hide, may be considered as a chemical industry. It is evident that if this view of the significance of the title were taken, "Chemicals and Allied Products" would properly cover every manufacture except those like furniture making, machine construction, or textiles, in which the material remains unchanged in composition during the manufacture but is turned, or cast, or woven into other shapes. The popular idea of the term limits its application but admits as chemical industries the manufacture of gunpowder, fertilizers and similar mixtures, whose ingredients

[1] Address delivered before the American Institute of Chemical Engineers at Philadelphia, December 9, 1909.

[2] Bull. 92, Census of 1905, p. 9, by Charles E. Munroe.

undergo no chemical change during the process of compounding the mixtures. It thus became necessary to decide arbitrarily upon the industries to be included. Those so included at the census of 1905 may be divided into the following classes: sulphuric, nitric, mixed and other acids; sodas; potashes; alums, coal tar products; cyanides, wood distillation; fertilizers; bleaching materials; chemicals produced by the aid of electricity; dyestuffs; tanning materials; paints and varnishes; explosives; plastics; essential oils; compressed and liquefied gases; fine chemicals; general chemicals.

These were consequently divided into nineteen different classes which were given separate treatment. The combined statistics for these classes for the censuses of 1900 and 1905 are set forth in the following table, the statistics of these two censuses only being compared because they alone dealt with the same materials:

TABLE I. CHEMICALS AND ALLIED PRODUCTS OF THE UNITED STATES, 1900 AND 1905

	Establishments. Number.	Wage Earners. Number.	Total Wages.	Materials Used. Cost.	Products. Value.
1905	1,786	59,198	$29,515,863	$176,400,680	$282,169,216
1900	1,691	46,700	21,783,335	124,018,044	202,506,076
Increase	95	12,498	7,732,528	52,382,636	79,663,140
Per cent. of increase	5.6	26.8	35.5	42.2	39.3

ter was improved and possibly indicates that a better class of labor was employed, and, since the percentage increase in the number of salaried officials for these establishments was 29.6, while the percentage increase in salaries was but 32.4 it is obvious that the wage earners fared, on the whole, better than the salaried officials.

A wholesome feature to be observed is that while the increase in the number of men employed was 12,104, the increase in the number of women employed was but 413, while there was a decrease of over 10 per cent. in the number of children employed. I speak of this condition as a wholesome one because, outside of the clerical and perhaps analytical work, the duties to be performed in these establishments is essentially man's work.

From Table I. it is observed that there was an increase in every item enumerated, but that not only was the actual increase in the number of establishments less than that of any other item, as was to be expected, but that the percentage increase was less. This indicates that the growth of these industries was rather by increased production of existing establishments than by the creation of new ones. In fact, in a more detailed analysis it was found that in some industries the number of establishments had actually decreased, though each of the other items, as enumerated in Table I., showed an increase.

The greater percentage increase in wages over that of the percentage increase in wage earners shows that the lot of the latter was improved and possibly indicates that a better class of labor was employed,

The greater percentage increase in the cost of materials used as compared with the percentage increase in the value of the products shows the growing necessity of intelligent and careful management and skillful workmanship to prevent waste and to increase yields. This is emphasized by examination of the additional item of miscellaneous expenses which, while less in the total than any of the values given in Table I., showed an increase of 77.2 per cent.

As indicated, the census classification of "Chemicals and Allied Products" which gave the data just discussed is a purely empirical one, and it deals with but a very few of the true chemical manufactures of the United States. It is not possible to derive from the returns, of the various

industries as taken, the data for an exact scientific classification such as has been referred to above. Yet, in order to arrive at a better conception of the application of chemistry in manufacturing industries and its magnitude, we may follow such a scheme of classification as that employed in many chemical technologies, though here again we meet with the difficulties common to classification and we are compelled to include in our data some of the products of purely physical processes, either because these processes are operated collaterally with, or related to, the predominating chemical processes, or else because the products are closely associated with the chemical products. In assembling this data it should be said that in order to compare the data of the different epochs one must first eliminate from the data of 1900 the returns for neighborhood industries, for the census of 1905 was a factory census considering only the results of manufacture as carried out in factories, and not solely for consumption at the point where manufactured as is generally the case with neighborhood industries. The results of this treatment are set forth in Table II. than is set forth in Table I. The increase is easily accounted for by noting that items such as soap, with a product valued at over $68,000,000; glass over $79,000,000; illuminating gas over $125,000,000; dairy products over $168,000,000; refined petroleum over $175,000,000; paper and wood pulp over $188,000,000; bread and other bakery products over $269,000,000; sugar and molasses over $277,000,000; vinous, malt and distilled liquors over $340,000,000; smelting and refining of copper, lead and zinc over $461,000,000; iron and steel over $905,000,000, and many other items have been added to those embraced in Table I.

The simple enumeration of these items indicates how incomplete the statistics usually presented as those of the chemical industries are and how insufficient the popular conception of the chemical industries is. Yet even the data of Table II. does not present the case in full since all agricultural products, amounting in value in 1900 to $4,717,069,973 are really the results of chemical processes and are therefore the products of chemical industries although not factory products.

TABLE II. CHEMICAL INDUSTRIES OF THE UNITED STATES, 1880 AND 1905

	1905	1900	1890	1880
Establishments, number	56,580	53,567	40,451	34,864
Wage earners, average number	1,107,714	943,166	677,123	490,776
Wages, total	$ 575,635,257	$ 438,404,062	$ 305,884,278	$ 176,227,726
Materials used, cost	2,933,660,817	2,215,162,767	1,247,239,582	924,573,773
Products, value	4,716,490,371	3,628,641,475	2,152,490,514	1,357,503,293

Table II., imperfect though it be both in the industries it includes and in those it omits, gives a better conception of the actual magnitude of the industries in which chemical transformations play a part, and which are therefore really chemical industries, than Table I. does, and in so doing it shows the value of the products for 1905 alone to be nearly seventeen-fold greater

As with Table I. so with Table II., the deductions are more readily drawn by observation of the increase and percentages of increase for each item at the various epochs. These have, therefore, been ascertained and are set forth in Table III.

Considering now the data of Table II. and more particularly the increases and percentages of increase set forth for each

TABLE III. INCREASES AND PERCENTAGES OF INCREASES FOR CHEMICAL INDUSTRIES

	1900 to 1905		1890 to 1900		1880 to 1890	
	Increase	Per Cent.	Increase	Per Cent.	Increase	Per Cent.
Establishments, number	3,013	5.6	13,116	32.4	5,537	16.0
Wage earners, average number	164,548	17.4	266,043	39.3	186,347	38.0
Wages	$ 137,231,195	31.3	$ 132,519,784	43.3	$129,656,552	73.6
Materials used, cost	718,498,053	32.4	967,923,182	77.7	322,665,809	84.9
Products, value	1,087,848,896	30.0	1,476,150,961	68.6	795,987,221	58.6

epoch in Table III., while keeping firmly in mind the fact that we are here dealing with two ten-year periods and one five-year period, it is again to be noted that both the actual and percentage increases in the number of establishments are the smallest of all the various increases set forth and that increase for this item for the 1900–05 period is not only actually less than for 1890–1900 and 1880–90, as should be expected, but is proportionately less, thus emphasizing what has been deduced from Table I. as to the increased production of existing establishments.

Likewise the consideration of the data for this larger number of industries extending over a greater length of time shows that not only is the percentage increase in wages nearly as great at the census of 1905 as those for cost of materials and greater than the value of products, but that, while the proportionate increase in the number of wage earners for the 1900–05 period is less than that of 1890–1900, the proportionate gain in wages is greater. In fact, all statistics point to markedly improved conditions for the wage earner in the chemical industries, and to his increased participation in the income from the enterprise. This fact is one to be reckoned on by the chemical engineer in making up his estimate for the cost of a projected enterprise which it is proposed to install.

The statistics of Tables II. and III., on the other hand, do not so markedly support the deductions drawn from Table I. as to the increase in cost of materials used when compared with the increase in the value of the products in 1900–05. However, when we consider the larger items included in these later statistics, such as iron and steel, smelting and refining of copper, lead and zinc, and others, we may each of us recall a variety of labor-saving devices which have been invented and introduced for cheapening the cost of production and handling of the raw materials of these industries, and that the inventions have increased in number and perfection with the growth in magnitude of these industries.

An increase in cost of materials is in conformity with the long-recognized natural law of supply and demand. A modification of this law through which labor may get its fair share of increase and capital may get its fair share of increase while the actual cost may not proportionately be increased has been brought about in recent times through the increase in the magnitude of the unit of demand, or in other terms, the quantity handled. As stated, this has to an extent been rendered possible by the introduction of labor-saving machinery, much of which has been invented in this country.

But in my opinion, and if I read aright the reports of foreign commentators on our chemical industries, in their opinions, the chief modification in the operation of this law has been made in this country through the development of "team work," though the writers style it organization or systemization.

Entering on my fortieth consecutive year

of college teaching, I might, from what has been so persistently dinned into my ears, have been led to believe that "team work" originated in the minds of the college youths who flock to Franklin Field or to the Harvard Stadium. Sitting on the bleachers with practical politicians and presidents, I might be led to suppose that "team work" was an invention of the professional athlete. As a fact the idea of "team work" is a very old one and military in its essence and original application. It is embodied in our national motto. It is commemorated in the "Charge of the Light Brigade." But this older practise, while greatly promoting efficiency, demanded such unreasoning subordination that the private soldier was properly looked upon as but "food for powder," and when this system was introduced into the factory the operator became but "a cog in the machine."

The modification in this plan of "team work" which has been developed to such advantage in the industrial plants of this country has come through a recognition of the great value of individuality and the necessity for its preservation and development, and it has been demonstrated that the higher the intelligence of the individuals who merge their entities with that of their fellows in a common purpose, and the more complete their comprehension of the means used and the end sought, the more successful is the result whether gauged by the quality, or the quantity, or the cost of the output. I am happy to say that the chemist has destroyed the older military idea, even in the army, for by his invention of high-powered smokeless powder he has compelled armies to fight in open order so that each individual must exercise his own powers in attack and defense, and be trained to take the initiative in case of necessity.

Naturally the application of labor-saving machinery and of "team work" is most readily made and yields most efficient results in the production, transportation and handling of the raw materials of our larger industries, and it is in these that we find the smaller proportionate increase in the cost of materials.

American industries, in which the chemical industries are included, have signalized themselves by the introduction of standards, by the introduction of interchangeable parts into mechanisms, by the wide application of labor-saving machinery and by the use of "team work." Yet notwithstanding the vast resources of this country, their ease of access, and the cheapening, by methods such as described, of many of costs of production, the cost of "living," not only here but throughout the civilized world, has steadily increased, and I attribute this largely to the work of the chemist.

At St. Louis, in 1904, I said:

Technical chemistry, then, invades the domains of economics, of politics and of diplomacy. A striking example of its effects in economics and politics is found in the settlement of the silver question. Gold is a most widely diffused metal. It has, for instance, been shown by assayers at the U. S. Mint at Philadelphia that if the gold in the clay of the bricks of which the buildings of the Quaker City are built could be brought to the surface, the fronts would all be gilded. In the past our processes for the isolation of this metal have been so costly that only the richer ores would bear treatment. Large bodies of low-grade ores which have been discovered and mountains of tailings carrying values were looked upon as worthless, while enormous quantities of copper, lead and other metals containing gold were sent into the market to be devoted to common uses, because the cost of separation was greater than the value of the separated products. Eight years ago, when the "silver question" was made the national issue, while the orators were declaiming from the stump, the chemists were quietly working at the problem in their laboratories and factories. Manhé's process for bessemerizing copper

ores was combined with the electrolytic refining of the product, so that even traces of gold were economically recovered, while the cyanide processes, such as the MacArthur-Forrest, the Siemens-Halske, the Pelatan-Clerici and others for the extraction and recovery of gold from low-grade ores and tailings, were successfully worked out and put into practical operation to such effect that by the cyanide processes alone gold to the value of $7,917,129 was recovered in the United States in 1902, which is more than was ever won throughout the whole world by all methods in any one year up to 1661, and probably up to 1701. The data for other purposes are not at hand for 1902, but the returns for 1900 show that gold to the value of $88,985,218 was recovered in the treatment of lead and copper ores in the United States, of which $56,566,971 worth was recovered in refining. It has but recently been publicly proclaimed in this city of St. Louis, that the "silver question" is settled, and it is settled, but it was settled largely through the efforts of the technical chemist and metallurgist.

With the improvements in methods and diminution in cost of extraction the Pactolean stream has continued to flow in steadily increasing volume[8] until the flood of gold has become so great that its purchasing power has become markedly reduced, and costs, measured in terms of gold, have become markedly greater. With this condition well determined the chemist has again stepped in to increase the cost of living by requiring the application of costly methods of inspection of food, drugs and other articles of consumption; by demanding the elimination of preservatives which permitted the abundance of the harvest being kept till time of need; or the plethora of one locality being sent to the land smitten with leanness; by insisting on the introduction of expensive sanitary arrangements. Pure food laws are the vogue, and all the other needs of man are becoming the subject of special legislation, some wise, but much otherwise. It would prove an interesting exhibit if a statistician were to assemble the actual costs in the administration and execution of these laws in this country alone during the past five years.

I speak with earnestness because I have repeatedly been a participant in these movements, and am even now engaged in an analogous humanitarian enterprise, and I know that a certain result of all such endeavors to improve the lot of man is to put the community to an increased expense.

Having confessed myself, and having found my profession guilty, as charged, I now assert that a chief duty of our profession is to determine methods by which the income may be increased or the costs of living in the land decreased, or preferably both, and I urge as a first measure the advocacy of the policy of preventing any material from leaving the country until it has passed through all processes of manufactures of which it is capable. The meaning of this is evident on inspection of the exports of domestic merchandise prepared by the U. S. Bureau of Statistics, where we find that in 1908 over 885 million dollars worth, or 48.19 per cent., of the total exports consisted of cotton, breadstuffs, meat and dairy products, and coal, much of which had not undergone any degree of manufacture whatever. All this food should have been elaborated in this country into brain and brawn, and the coal made to yield its energy, and these should have been expended here in manufacture. We should further have put into manufactured form the raw materials of other lands.

Inspecting, on the other hand, the table of imports of merchandise prepared by the U. S. Bureau of Statistics, we find in 1908

[8] PRODUCTION OF GOLD

Year	World's Production		Production in U. S.	
	Fine Ounces	Value	Fine Ounces	Value
1878	5,761,114	$119,092,800	2,476,800	$51,200,000
1888	5,330,775	110,196,900	1,604,841	43,175,000
1898	13,877,806	286,879,700	3,118,398	64,463,000
1908	21,378,481	441,932,200	4,574,349	94,560,000

TABLE IV. VALUES OF EXPORTS OF DOMESTIC MERCHANDISE, BY PRINCIPAL ARTICLES AND CLASSES, IN ORDER OF MAGNITUDE IN 1908, DURING THE YEARS ENDING JUNE 30, 1902–1908

Order of Magnitude, 1908	ARTICLES	1902	1903	1904	1905	1906	1907	1908 Value	1908 Per Cent. of Total
1	Cotton, unmanufactured	$290,651,819	$316,180,429	$370,811,246	$379,965,014	$401,005,921	$481,277,797	$437,788,202	28.86
2	Breadstuffs	213,134,344	221,242,285	149,050,378	107,732,910	186,468,901	184,120,702	215,260,588	11.73
3	Meat and dairy products	199,861,378	179,839,714	176,027,586	169,998,873	210,990,065	202,392,508	192,802,708	10.51
4	Iron and steel, and manufactures of	98,552,562	96,642,467	111,948,586	134,728,363	160,984,985	181,530,871	183,982,182	10.03
5	Copper, and manufactures of	43,820,070	40,594,613	58,119,006	87,564,009	83,178,635	96,600,698	105,872,711	5.77
6	Mineral oils	72,302,822	67,253,533	79,060,469	79,793,222	84,041,327	84,855,715	104,116,440	5.67
7	Wood, and manufactures of	47,779,848	57,748,535	65,428,417	58,002,977	69,080,394	83,349,575	81,521,805	4.44
8	Leather, and manufactures of	29,798,323	31,617,389	33,980,615	37,936,745	40,642,858	45,476,969	40,688,619	2.22
9	Tobacco, and manufactures of	32,772,849	40,444,689	34,683,531	35,491,019	34,218,847	39,113,011	39,463,679	2.15
10	Coal	20,765,461	21,206,498	27,820,328	29,158,322	28,216,376	34,727,762	39,355,759	2.15
11	Animals	44,871,684	34,781,193	47,977,875	46,728,281	49,139,568	41,203,080	34,101,289	1.86
12	Cotton, manufactures of	32,108,362	32,216,304	22,403,713	49,666,080	52,944,033	32,305,412	25,177,758	1.37
13	Agricultural implements	16,286,740	21,006,622	22,749,635	20,721,741	24,554,427	26,936,456	24,344,898	1.33
14	Cars, carriages, etc	9,872,516	10,499,195	10,936,618	10,610,437	17,788,425	20,513,407	22,072,902	1.20
15	Naval stores	11,733,562	12,918,708	16,145,222	16,106,643	20,075,585	21,686,752	21,641,599	1.18
16	Oil cake and oil-cake meal[4]	19,779,142	19,743,711	16,899,257	21,498,085	23,386,218	25,738,471	21,064,974	1.15
17	Chemicals, drugs, dyes and medicines	13,626,887	14,150,493	15,065,682	16,595,523	19,155,989	20,373,036	20,873,155	1.14
18	Vegetable oil	15,308,638	16,234,362	12,618,881	16,632,232	15,906,081	19,550,514	19,633,967	1.07
19	Fruits and nuts	8,719,344	18,057,677	20,678,665	15,606,586	15,274,158	17,588,482	14,338,864	.78
20	Instruments for scientific purposes	5,389,476	7,130,508	8,297,723	8,172,980	10,887,774	13,661,455	11,578,010	.63
21	Fertilizers	6,256,035	6,724,301	7,112,512	7,620,886	8,686,965	8,596,711	10,970,931	.59
22	Paraffin and paraffin wax	8,858,844	9,411,294	8,859,964	7,789,160	8,808,245	9,030,992	8,740,929	.48
23	Seeds	8,027,824	9,455,288	2,583,325	2,557,747	8,912,662	10,094,609	8,683,688	.47
24	Paper, and manufactures of	7,312,030	7,180,014	7,543,728	8,238,088	9,536,065	9,856,733	8,064,706	.44
25	Furs, and fur skins	5,030,204	6,181,115	5,422,945	6,599,222	8,002,282	7,139,221	7,712,890	.42
26	India rubber, manufactures of	4,032,100	4,675,157	5,148,959	5,508,664	6,543,735	7,428,714	7,573,570	.41
27	Fibers, vegetable, etc., manufactures of	4,575,219	5,290,948	6,414,636	6,766,809	8,157,211	8,808,112	7,225,798	.39
28	Books, maps, engravings, etc	3,997,977	4,442,653	4,347,804	4,844,160	5,889,452	5,813,107	6,107,058	.33
29	Grease, grease scraps, etc	2,610,925	2,926,565	3,811,771	3,710,907	4,138,383	5,473,623	5,762,709	.31
30	Fish	6,563,199	6,717,274	7,857,047	6,527,863	7,559,178	5,536,856	5,685,916	.31
31	Household and personal effects	2,570,369	2,652,787	2,615,076	3,146,969	3,595,128	3,928,946	4,782,436	.26
32	Coffee, green	3,209,946	3,295,968	3,656,948	1,966,107	3,483,238	4,692,137	4,314,020	.24
33	Sugar, molasses and confectionery	3,237,329	3,104,653	3,522,805	4,131,707	4,526,334	3,973,360	4,068,357	.22
34	Paints, pigments and colors	2,096,379	2,350,937	2,756,581	3,126,317	3,773,064	3,931,899	4,001,824	.22
35	Vegetables	2,546,287	2,543,488	2,603,874	3,200,860	3,567,127	4,007,833	3,895,294	.21
36	Explosives	2,062,381	2,454,510	2,441,596	2,559,837	3,568,038	4,082,402	3,705,517	.20
37	Brass, and manufactures of	1,930,810	2,000,432	2,557,484	3,025,764	3,474,981	4,580,455	3,701,871	.20
38	Soap	1,630,938	2,452,777	2,499,938	2,670,231	2,781,179	3,806,097	3,407,220	.19
39	Musical instruments	3,694,143	3,381,509	3,230,982	3,144,787	3,168,052	3,256,063	3,371,521	.18
40	Hops	1,550,657	1,909,951	2,116,180	4,480,666	3,125,843	3,531,772	2,963,167	.16
41	Nickel, nickel oxide and matte	1,190,606	864,221	940,558	3,196,622	3,240,544	3,218,862	2,948,058	.16
42	Clocks and watches, and parts of	2,144,490	2,183,529	2,281,195	2,316,414	2,598,441	3,169,272	2,848,725	.16
43	Coke	1,720,457	1,912,459	3,228,233	2,228,442	2,435,604	3,013,088	2,718,885	.15
44	Glucose and grape sugar	2,319,286	2,460,022	2,949,545	3,206,794	3,489,192	3,017,527	2,540,640	.14
45	Glass and glassware	1,960,106	2,150,699	1,978,481	2,252,799	2,483,904	2,604,717	2,505,417	.14
46	Wool, manufactures of	1,512,457	1,722,128	1,987,938	2,035,054	2,119,518	2,239,106	2,219,815	.12
47	Lamps, chandeliers, etc	963,638	1,133,290	1,502,888	1,579,125	1,9[illegible]5,091	1,875,869	1,827,216	.10
48	Spirits, distilled	2,673,273	1,990,091	1,691,467	1,968,767	1,525,225	1,827,757	1,816,287	.10
49	Zinc, and manufactures of	2,017,191	2,346,629	1,710,211	3,085,245	2,780,199	2,143,574	1,606,032	.09
50	Hay	2,580,622	828,483	1,052,705	1,089,505	1,116,307	976,287	1,463,010	.08
51	Marble, stone, and manufactures of	1,761,696	1,465,244	1,589,790	1,283,219	1,466,561	1,433,123	1,248,996	.07
52	Starch	656,705	832,943	1,340,282	1,430,572	1,490,797	1,126,465	1,142,054	.06
53	Malt liquors	1,290,062	1,178,740	854,119	1,012,808	1,116,776	1,215,340	1,020,172	.06
..	All other articles	23,761,904	22,557,283	25,770,582	30,732,482	30,998,594	35,784,782	38,463,024	2.10
	Total	$1,355,481,861	$1,392,231,302	$1,435,179,017	$1,491,744,641	$1,717,953,382	$1,853,718,034	$1,834,786,357	100.00

[4] Corn oil cake not included.

TABLE V. IMPORTS OF MERCHANDISE, BY PRINCIPAL ARTICLES AND CLASSES, YEARS ENDING JUNE 30, 1902–1908

Order of Magnitude, 1908	ARTICLES	1902	1903	1904	1905	1906	1907	1908	
								Value	Per Cent. of Total
1	Sugar	$55,061,097	$72,088,978	$71,915,753	$97,645,449	$85,460,088	$92,806,253	$80,258,147	6.72
2	Chemicals, drugs and dyes	57,723,622	64,351,199	65,294,558	64,779,559	74,477,187	82,997,914	73,237,083	6.13
3	Cotton, manufactures of	44,460,126	52,462,755	49,524,246	48,919,936	63,048,322	73,704,636	68,379,781	5.72
4	Coffee	70,982,155	59,200,749	69,551,799	84,654,062	73,256,184	78,231,902	67,688,106	5.67
5	Silk, unmanufactured	42,635,351	50,011,050	46,100,500	61,040,053	54,080,504	71,411,899	64,546,903	5.40
6	Hides and skins	58,011,168	58,031,613	52,006,070	64,764,146	83,882,167	83,206,545	54,770,136	4.59
7	Fibers, vegetable, etc., manufactures of	39,036,364	39,334,521	40,308,837	40,125,406	51,437,581	67,422,557	54,467,572	4.56
8	Wood, and manufactures of	24,445,599	28,746,271	26,984,358	29,564,328	36,532,706	42,969,941	43,527,982	3.64
9	India rubber and gutta-percha, crude	25,652,977	31,004,541	41,049,434	50,729,873	46,035,685	60,206,418	37,753,266	3.16
10	Fruits and nuts	21,480,525	23,726,636	24,435,854	25,937,456	28,915,747	35,867,160	37,354,742	3.13
11	Fibers, vegetable, etc., unmanufactured	31,545,962	34,462,513	37,814,285	38,118,071	39,360,290	42,239,358	35,493,083	2.97
12	Silk, manufactures of	32,640,242	35,963,552	31,973,680	32,614,540	32,910,590	38,653,251	32,717,668	2.74
13	Iron and steel, manufactures of	27,180,247	51,617,312	27,028.812	28,510,164	29,053,987	40,587,865	27,607,909	2.31
14	Tobacco, and manufactures of	17,706,493	20,579,120	20,073,346	22,145,846	26,590,706	30,192,375	27,267,913	2.28
15	Tin, in bars, blocks and pigs	19,461,850	23,618,802	21,486,311	23,378,471	30,932,998	38,117,459	25,295,061	2.12
16	Copper, manufactures of	10,968,948	17,505,247	18,215,442	19,942,511	25,835,502	39,428,687	24,462,663	2.05
17	Wool, unmanufactured	17,711,788	22,152,961	24,813,591	46,225,558	39,068,372	41,534,028	23,664,938	1.98
18	Spirits, wines and malt liquors	15,246,640	17,171,617	16,662,702	17,652,323	19,257,590	22,104,235	20,771,804	1 74
19	Wool, manufactures of	17,884,463	19,546,885	17,733,788	17,893,663	23,080,683	22,321,460	19,387,978	1.62
20	Oils	9,300,198	12,283,957	11,179,442	11,593,520	13,723,948	17,068,777	18,292,893	1.53
21	Furs, and manufactures of	15,623,601	15,301,912	14,763,002	18,306,302	21,855,682	21,884,034	15,918,149	1.33
22	Diamonds and other precious stones	23,348,225	31,479,223	22,964,119	33,313,931	40,247,010	42,278,901	16,642,634	1.39
23	Articles, the growth, etc., of the United States, returned	5,815,628	7,170,573	9,899,470	9,079,124	11,134,912	11,833,983	16,599,766	1.39
24	Tea	9,390,128	15,659,229	18,229,810	16,230,858	14,580,878	13,915,544	16,309,870	1.37
25	Cocoa, crude, and leaves and shells of	6,656,504	7,820,087	8,878,709	8,577,649	8,697,515	13,376,562	14,257,250	1.19
26	Cotton, unmanufactured	11,712,170	10,892,591	8,541,510	9,414,750	10,879,592	19,930,988	14,172,241	1.19
27	Leather, and manufactures of	11,317,785	11,294,167	11,100,215	11,666,233	15,140,926	20.393,533	14,127,847	1.18
28	Earthen, stone and china ware	9,680,156	10,512,052	12,005,014	11,659,723	12,877,528	13,706,790	13,427,969	1.12
29	Fish	8,527,097	8.635,583	9,889,697	10,498,076	11,607,602	12,335,988	12,292,770	1.03
30	Paper, and manufactures of	4,223,125	4,733,036	5,319,086	5,623,638	6,998,761	10,727,885	12,223,058	1.02
31	Meat and dairy products	3,510,696	4,703,536	4,197,466	4,253,414	5,117,064	6,768,432	8,877,183	.74
32	Vegetables	7,039,885	4,581,355	7,008,602	3,983,272	5,092,932	5,728,472	8,289,068	.69
33	Toys	4,023,670	4,232,074	4,977,389	4,964,457	5,887,863	6,993,561	7,206,423	.60
34	Breadstuffs	2,580,295	3,023,160	3,247,503	6,557,847	4,513,667	5,892,968	7,188,214	.60
35	Copper ore	14,003,840	3,385,524	3,466,881	4,892,961	6,727,861	8,296,328	7,057,080	.59
36	Metal, and manufactures of, not elsewhere specified	6,223,883	7,057,202	7,092,125	7,050,118	7,888,565	10,825,446	6,768,637	.57
37	Glass and glassware	6,205,052	7,255,879	6,583,168	5,948,839	7,507,828	7,596,631	6,570,123	.55
38	Seeds	3,252,152	2,831,279	3,587,469	3,457,619	5,888,043	6,404,776	6,371,470	.53
39	Books, maps, engravings and other printed matter	4,133,215	4,323,938	4,529,187	4,589,858	5,599,948	6,451,809	6,036,698	.51
40	Coal, bituminous	5,810,450	10,562,185	5,043,824	3,713,748	4,367,750	4,184,541	5,123,862	.43
41	Fertilizers	2,426,758	3,100,276	3,503,726	4,524,700	4,446,360	5,341,430	4,970,461	.42
42	Hats, bonnets and hoods, and materials for	3,050,478	3,871,278	3,963,043	4,379,473	4,571,184	6,820,259	4,852,548	.41
43	Rice	2,926,921	3,061,473	3,078,430	2,010,966	3,082,208	4,392,146	4,798,553	.40
44	Animals	4,624,531	4,533,845	3,129,609	3,337,454	3,914,382	4,344,282	4,777,459	.40
45	Household and personal effects	2,984,244	2,856,007	3,040,523	3,263,384	3,941,875	3,835,354	4,446,187	.37
46	Feathers and down, crude, not dressed, etc	2,032,566	2,476,659	2,742,018	2,036,791	2,970,260	4,401,131	4,360,721	.37
47	Matting for floors, etc	3,817,866	3,780,050	3,609,795	3,600,088	3,831,486	3,769,202	4,333,044	.36
48	Art works	3,516,536	4,810,315	3.286,262	4,381,824	4,908,782	5,867,265	4,810,767	.36
49	Cork wood, or cork bark, and manufactures of	2,464,984	2,567,580	2,295,138	2,788,819	3,318,306	4,063,982	4,249,006	.36
50	Lead in ore	4,497,360	4,073,099	3.374,661	3,616,476	3,534,876	3,352,534	4,147,720	.35
51	Paper stock, crude	2,770,255	3,015,084	2,900,713	3,796,595	4,374,464	5,580,528	3,675,926	.31
52	Spices	3,685,242	4,815,125	4,366,008	4,583,856	5,188,116	5,113,000	3,591,587	.30
53	Hair, and manufactures of	2,055,536	2,775,084	2,727,062	3,428,404	3,854,849	3,604,599	3,561,012	.30
54	Iron ore	2,362,544	2,851,278	1,593,279	1,670,683	2,728,854	3,360,449	2,949,462	.25
55	Clocks and watches, and parts of	2,460,324	2,672,810	2,990,474	2,966,495	3,105,136	3,598,178	2,922,142	.25
56	Cement	1,478,452	3,607,666	2,052,962	1,355,696	1,394,447	3,778,114	2,100,598	.18
57	Bristles	2,047,881	2,654,604	2,367,301	2,370,498	2,695,746	3,261,877	2,097,777	.18
58	Jewelry and manufacures of gold and silver	2,642,345	2,007,483	2,048,821	1,303,652	1,739,963	1,779,527	1,672,275	.14
	All other articles	50,318,903	57,875,712	52,552,007	57,181,870	78,919,068	88,063,181	74,169,712	6.21
	Total	$903,320,948	$1,025,719,237	$991,087,371	$1,117,513,071	$1,226,562,446	$1,434,421,425	$1,194,341,792	100.00

but a little over 210 million dollars' worth, or 17.87 per cent., of our imports consisted specifically of unmanufactured materials, such as silk, hides and skins, india rubber and gutta percha, wool, cotton, copper, lead and iron ores, and bristles, which would properly go into manufactures here.

We sit back glorying in our country. Its wide extent. Its rich resources. Its teeming millions of independent and self-respecting people. And yet after our fleet has circumnavigated the globe we continue to sacrifice the fertility of our soils to the support of older civilizations and remain content, while ranging ourselves with those nations that live solely on their primary resources, since the "balance of trade" is in our favor. But we as chemists know that this condition can not last. We know that the average fertility of our soil has been growing steadily less and that only by following sound scientific practise can the fertility of the impoverished soil be restored.

The utilization of the soil as a chemical factory is but one of the problems with which the chemist has to deal. That which appeals most nearly to us as chemical engineers is the item that appears as second in magnitude in the table of imports of merchandise and which has held this second place for years, namely, "chemicals, drugs and dyes," for this category embraces those substances commonly known as chemicals, or the products of the "black art." In 1908, we imported 73,237,033 dollars worth of this class of materials or 6.13 per cent. of our total imports. While we exported but 20,873,155 dollars worth, or 1.14 per cent. of our total exports. There was, therefore, a balance of $52,363,878 against us in this item in which the chemical engineers of this country are most nearly concerned. It is true that among these imports are upwards of $15,000,000 worth of crude drugs and dyewoods, and quantities of other crude material, but there are many million dollars worth of substances included here that should have been manufactured in this country. Attention need only to be called to the acids imported to a value of over $1,300,000 to emphasize this fact, for while we are seeking an outlet for our sawdust, we find in this list nearly 9,000,000 pounds of oxalic acid. Or attention might be called to the more than $7,000,000 worth of coal tar products and preparations, not medicinal. Had this been accomplished there is little doubt that our exports of such substances would also have been large. And what is true of the industries commonly called chemical would equally apply to those larger chemical industries not included in the common category.

Another policy we should follow is the promotion of chemical manufactures throughout a larger portion of our great territory. For this purpose I have prepared Table VI., showing by states the locations of each of the 1,786 establishments

TABLE VI. NUMBER OF ACTIVE ESTABLISHMENTS FOR CHEMICALS AND ALLIED PRODUCTS, BY STATES, 1905

	1905		1905
Alabama	27	Mississippi	7
Alaska	1	Missouri	47
Arizona	—	Nebraska	4
California	63	Nevada	3
Colorado	6	New Hampshire	1
Connecticut	40	New Jersey	144
Delaware	13	New York	264
District of Columbia	3	North Carolina	42
Florida	15	Ohio	128
Georgia	75	Oregon	4
Illinois	89	Pennsylvania	315
Indiana	52	Rhode Island	17
Indian Territory	1	South Carolina	26
Iowa	6	Tennessee	22
Kansas	10	Texas	3
Kentucky	21	Vermont	3
Louisiana	12	Virginia	62
Maine	9	Washington	9
Maryland	50	West Virginia	25
Massachusetts	77	Wisconsin	19
Michigan	52	Wyoming	1
Minnesota	10		

reported for chemicals and allied products at the census of 1905, and I find that seven states or territories, viz., Arkansas, Idaho, Montana, New Mexico, North Dakota, South Dakota and Utah did not at that time possess a single establishment devoted to any of the large number of industries embraced in chemicals and allied products. Oklahoma, New Hampshire and Wyoming each possessed but one, and the District of Columbia, Nebraska, Nevada, Oregon, Texas and Vermont each less than five.

In order to bring this matter of the distribution of the industries manufacturing chemicals and allied products more clearly to your attention I have, through the courtesy of the director of the bureau of the census, had prepared a map of the United States showing the location of the establishments, both principal and subsidiary, manufacturing sulphuric acid, those making explosives, and those engaged in wood distillation, each being a typical industry, and the sulphuric acid industry being generally accepted as of fundamental importance.

From this chart it appears that 13 states and territories, being the seven already named (Arkansas, Idaho, Montana, New Mexico, North Dakota, South Dakota, Utah) with Iowa, Nebraska, New Hampshire, Nevada, Oregon and Wyoming, containing 7,648,000 out of the 76,303,387 inhabitants of the continental United States in 1905, or over 10 per cent. of the whole, did not possess a single establishment devoted to any one of these industries.

Considering sulphuric acid only, which is so important an industry that it has frequently been referred to as an index of the state of civilization of a people, we find that 23 states and territories, namely, the 13 just enumerated, together with Delaware, District of Columbia, Kentucky, Maine, Minnesota, Missouri, Oklahoma, Washington and West Virginia containing 19,562,200 population, or 25.6 per cent. of the total did not possess a single sulphuric acid plant within their borders.

Turning now to the east, we find that 11 out of the 13 original colonies, viz., Connecticut, Georgia, Maryland, Massachusetts, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island, South Carolina and Virginia, contained 30,695,000 population, or 40.2 per cent. of the total, and 100 sulphuric acid factories, or 67.1 per cent. of the total number existing in the country. Analysis of the statistics of the separate states shows that the number of these establishments does not follow the population, Georgia, for instance, with about one fourth the population of New York, having twice the number of sulphuric acid factories that New York had.

I am aware that the number of establishments in an industry is an unsafe criterion as to the magnitude or importance of that industry, but this feature has been chosen as lending itself most easily to graphic demonstration. I have therefore assembled, by geographic divisions, in Table VII., data for the quantity of sulphuric acid produced, and we find that inspection of this leads to much the same result as to that which was drawn from the consideration of the distribution of the establishments.

TABLE VII. QUANTITY OF SULPHURIC ACID PRODUCED IN THE UNITED STATES BY GEOGRAPHIC DIVISIONS, 1905 AND 1900

Division	1905	1900
	Tons	Tons
North Atlantic	768,647	734,669
South Atlantic	540,593	520,575
North Central	349,906	153,979
South Central	141,107	87,665
Western	69,184	51,235
Total for United States	1,869,437	1,548,123

All investigations show that there is an enormous extent of fairly well populated area in this country yet awaiting development by the chemical engineer, and I commend this field of service to your attention.

As a field in which costs may be diminished, attention may be called to the saving of waste. So much has been said on this subject that I hesitate to dwell upon it lest I weary you. But I venture to suggest that one remedy for waste, which has not been so markedly dwelt upon as it deserves, is by a change in location, and I take as an example of this the gas industry.

I have long looked upon our present custom of transporting coal long distances to be converted into gas as uneconomic, for a not inconsiderable quantity of coal is burned to provide the energy with which to haul this coal. Not only that but, since the gas constitutes but a very small percentage by weight of the coal, there is a considerable waste in hauling the coke, with its ash, and the by-products. Further, to provide for emergencies, large stocks of coal must be accumulated in advance at the gas works, and as coal, particularly gas coal, begins to deteriorate as soon as it is removed from the mine, there is a very considerable loss going on all the time from this cause. Further, as the by-products or residuals are now purchased in the crude state in relatively small quantities at the different gas works, a large part of their value is consumed in collecting and transporting them to central refineries.

By producing the gas at the mine and shipping it by pipe line the cost of haulage on the coke, with its ash, and crude by-products, is saved. The wastage of coal by weathering is saved. The cost of collection and transportation of the crude residuals is saved. Such coke as is not needed for industrial purposes can be converted in producers into gas which, by means of internal combustion engines, can be used in generating electricity for distribution, and the ash from this coal can be put into the mine for use as a filler in place of coal.

It is evident that gas can, under these circumstances, be made and delivered at a much less cost than is the case at present, though it may be necessary after long travel to enrich it near the point of consumption. Furthermore, the valuable areas now occupied by gas plants in our cities can be given up to more concentrated industries and cheap country lands be substituted for them.

I venture further to suggest that frequently an urgent reason for saving waste is to suppress a nuisance, for I do not hesitate to assert that the existence of a public nuisance is evidence of the existence of an economic waste.

Almost at the outset of my professional life, in 1872, I became involved in the famous Miller's River Nuisance case and it fell to my lot to examine, on behalf of the citizens of Cambridge, Mass., the large slaughtering houses which were believed to be the cause of the nuisance, and to study the operations going on within them. The conditions were very complex and there were a variety of causes which led to the creation and maintenance of this most horrible and most extensive nuisance, but among other causes I found that the slaughtering houses had permitted much valuable blood and offal to escape into the stream and that at that time one establishment alone was pouring into the river, in the water in which it had steamed its hogs, over five tons of gelatinous matter per week, and this was done in ignorance of the existence of this matter in the tank waters.

What I have found to be true regarding matter, I have also found to be true as regards energy, and I cite as an example

the nuisance of "cannonading" in blasting, which is proof in itself of the use of unnecessarily excessive charges of explosives.

But in urging the abating of a nuisance or advising the saving of waste or the conserving of resources, we should not fail to point out that it can usually be accomplished only with added expense, and that a profit can rarely be realized unless the operations are carried out on a quite considerable scale. In fact, it seems to be an economic law that only the rich can really save; that "to him that hath shall be given"; for the poor must pay the price of much subdivision and the consequent cost of much handling and a multiplicity of containers.

In fact, we should make it plain that the advocacy of the saving of waste in manufacture and of conserving our resources necessarily implies the use of great aggregations of capital and the carrying on of large scale operations under a single management. It means the application of methods such as have been applied with great success in the manufacture of hog products or in the refining of petroleum. In dealing with coke at the census of 1905, I found that of the 37,376,251 tons of coal coked in the United States in that census year, only 3,317,585 tons, or 8.9 per cent., were coked in by-product ovens, and I estimated from the yields and values of the by-products which were recovered that had all the coal been coked in by-product ovens there was a possible saving of $37,-492,136.[5] This is an enormous amount to save in a single industry in a single year, and if the saving could be made an accomplished fact it would go far toward wiping out that humiliating account against us in our imports of "chemicals, drugs and dyes." But I have never failed to recognize the fact that this could only be accomplished by those controlling large capital, and that it meant the "killing off" of a large number of minor establishments, and I have further recognized the fact that the apparent savings set forth could not be realized until the charges against the more costly plant had been satisfied, nor until the market had been so readjusted that it could absorb this greatly increased output of by-products.

As an example of the commercial advantage resulting from the abating of a nuisance, I cite the instance of Ducktown, Tenn., whose smelters have for decades been notorious offenders. I will not repeat to you the details by which their devastating sulphurous fumes have been converted into valuable merchandise, since they have been so well set forth in current literature, but will simply note that, by report, this saving has resulted in the suspension of a number of the sulphuric-acid works in the contiguous region, and I am ready to believe this report to be true, for I look upon this result as a natural consequence of the operation of a wholesome law in economics.

However, all of the endeavors avail but little so long as we remain a dependent nation, which the quantity of manufactured "chemicals, drugs and dyes" imported by us indicates that we are, and especially while we import over seven million dollars' worth of coal-tar products and nearly two million dollars' worth of ammonium sulphate as we did in 1908, and yet allow 37,000,000 dollars' worth of the by-products produced in the coking of our coal to be wasted. It is evident that there is still a wide opportunity for the employment of the chemical engineer in developing our chemical industries.

I find that I have been led to devote my attention to the chemical industries of the

[5] Bull. 65, U. S. Census of Manufactures, 1905, p. 18.

United States when you have asked me to treat of those of America. I have, however, limited myself not because I consider our country America, but because of the limited amount of information that I have been able to secure relative to the other countries in North and South America. Such as is available for Canada is found in a paper by Dr. W. R. Lang, published in the *Transactions of the Canadian Institute* for 1904, from which it appears that, in 1903, salt was produced in the Dominion to the value of $334,000, and arsenic, in 1901, to the extent of 1,347,000 pounds. Sulphuric acid was produced in Quebec, Ontario and British Columbia, but neither the number of factories, nor the extent of the output is given. However, in treating of the plant at Ontario, which produced about 15 tons of acid per day, it is stated that imported brimstone was used as the raw material, and this in the face of the fact that Canada abounds in pyrites. The wood-distillation industry flourishes in that country, the plant of the Lake Superior Power Company being, it is said, the largest retort plant in the world, but no statistics of production are supplied. Ammonia liquor was produced to the extent of 235,000 pounds of 28° B. strength, a larger part of it being exported. Soap was produced by some 15 concerns employing about 2,000 hands, the value of the product in 1902 being approximately $3,000,000. Glycerine was obtained from the soap lyes, one works being capable of treating 10,000,000 pounds of lye annually. Petroleum refining was carried on at Sarnia, the factory being able to treat 60,000 barrels of crude oil per month. Calcium carbide was made in two works, carborundum and graphite in one. There was a limited manufacture of fine and heavy chemicals. This about completes the tale for Canada.

My efforts to obtain information relative to the Central American and South American states have been less successful, though I have searched the literature and consulted officials from and to these countries. "The Statistical Abstract of Foreign Countries" recently published by Mr. O. P. Austin, chief of the U. S. Bureau of Statistics, covers the exports and imports of these countries for a decade, and it appears to be the only authoritative and detailed report concerning them, yet a painstaking search of the tables of exports for each of these Central American and South American countries shows no other chemical items than borate of lime, iodine and nitrate of soda from Chile; charcoal from British Guiana and Argentina; fermented and distilled liquors from several of the countries, especially from the West Indian Islands; and dyestuffs and extracts from a number of states. Literature relating to the commercial resources and industrial activities of the Pan-American republics, other than the United States, is apparently quite meager, and information regarding their industrial activities appears not to have been collected either by the countries themselves or by students of commerce and industry. It does appear, however, from what information can be obtained, that the resources of these countries are in an undeveloped condition and that these countries present an almost virgin field for development by the chemical engineer.

I have myself attempted to inspire one such development, for at the outset of the undertaking of the construction of the Panama Canal by the United States, I advised that dynamite, which has been consumed in enormous quantities in the excavation work, and the manufactured "raw" materials of its manufacture, be made upon the Isthmus. The easy access

to the nitrate-of-soda deposits of Chile, making but a brief water transportation necessary for delivery, and the existence of pyrites in great abundance in the vicinity of the Isthmus making the production of sulphuric, and hence mixed, acids easy and simple, were a few of the many advantages which would follow the adoption of this plan. But not the least would be the civilizing influence which chemical manufacture always exerts. It is unnecessary to say that up to the present, I have been unsuccessful in my endeavors to introduce chemical manufactures into the Central American states, but I trust that you, who have done me the honor to listen to me, may succeed where I have failed.

Charles E. Munroe
George Washington University

SCIENTIFIC NOTES AND NEWS

The funeral of Mr. Alexander Agassiz was held in Appleton Chapel, Harvard University, on Sunday, April 3.

A testimonial dinner to Dr. Charles Frederick Chandler was given at the Waldorf-Astoria on April 2, to permit his former students and associates to express, before his retirement, their appreciation of his forty-six years of service to Columbia University, and his lifetime of devotion to the cause of education and science. It was announced that a lectureship in honor of Dr. Chandler would be endowed by his former students and that the chemical museum of the university would be named in his honor.

Dr. T. Muir, F.R.S., has been elected president of the South African Association for the Advancement of Science for the meeting in Cape Town, the date of which is not yet set.

Dr. Richard Dedekind, professor of mathematics at Brunswick, has been elected a foreign member of the Paris Academy of Sciences.

Sir James Dewar, F.R.S., has been elected an honorary member of the American Chemical Society.

Mr. Frederic A. Lucas, curator-in-chief of the Brooklyn Museum, has been elected a life member of the American Museum of Natural History on account of the practical assistance which he has rendered it and because of his contributions to science.

A dinner was given in honor of Sir John Murray in London on April 5, in connection with the Michael Sars expedition for the exploration of the North Atlantic.

Professor L. A. Wait, head of the department of mathematics at Cornell University, will retire from active service at the close of the present academic year.

Dr. A. R. Ward, director of the State Hygienic Laboratory at Berkeley, Cal., has been appointed chief of the veterinary corps of the Philippine Islands.

At the American Museum of Natural History Dr. E. O. Hovey has been promoted to the curatorship in geology to succeed Dr. R. P. Whitfield, who shortly before his death became curator emeritus. In the department of anthropology, Dr. Pliny E. Goddard has been appointed associate curator, Mr. Harlan I. Smith has been advanced to associate curatorship, Dr. Herbert J. Spinden has been appointed assistant curator and Mr. Alanson Skinner has been added to the list as assistant. A new department of public health has been established with Professor C. E. A. Winslow as curator. A new department of woods and forestry has been established, with Miss Mary C. Dickerson in charge.

Dr. Hermon C. Bumpus, director of the American Museum of Natural History, is making an expedition to Mexico to plan the reproduction of certain prehistoric ruins for structural use in the new hall of Mexican archeology. Mr. Frank M. Chapman, curator of ornithology, accompanied Dr. Bumpus to make studies and collect specimens for a group of Mexican birds.

Chauncey Juday, lecturer in zoology at the University of Wisconsin and expert on the staff of the Wisconsin Natural History Survey, has just returned from a five-weeks trip through Central America, where he studied

the lakes in the volcanic mountain region. He found Lake Atitlan, Guatemala, to be the deepest, being 1,000 feet deep, and the largest, being 24 miles long and 12 wide. It was also the coldest, being, in spite of the tropical climate, but 67 degrees. Its elevation is 5,000 feet above the sea level. Fish and vegetable life he found to be scarce in all these lakes of the volcanic region. In San Salvador he explored Ilopango, 727 feet deep, and Coatepeque, 350 feet deep; and in Guatemala Lake Amatitlan, 110 feet deep. Although Ilopango had two islands raised in it by volcanic action thirty years ago, Mr. Juday now finds no trace of such action there.

DR. E. G. BILL, of Yale University, has received leave of absence for the coming academic year, which he will spend in the study of geometry at the University of Turin.

DR. FREDERICK STARR, associate professor of anthropology in the University of Chicago, who has been conducting anthropological researches in Japan since September, is expected to return to Chicago in the early part of June.

THE University of Minnesota has appointed Professor Thomas G. Lee, director of the institute of anatomy, as its delegate to the Second International Anatomical Congress, Brussels, August 7–11, and to the Eighth International Zoological Congress, Graz, Austria, August 15–20. Dr. Lee sails on April 9 and will spend the intervening time in visiting the principal laboratories in Europe in the interests of the new institute of anatomy about to be erected at the University of Minnesota, at a cost of $200,000.

A SMALL party of geological students from the Massachusetts Agricultural College spent the spring recess in an examination of various sections and other geological features in the Hudson River Valley. The excursion was in charge of Professor C. E. Gordon.

Nature states that the Reale Istituto Lombardo has awarded the following prizes: the mathematical prize for an essay on theory of transformation groups is awarded to Professor Ugo Amaldi, of Modena, for his essay on the determination of all the infinite continuous groups of analytic point transformations in three-dimensional space; the Cagnola prize, relating to miasma and contagion, is awarded to Professor Aldo Castellani, of the hospital for tropical diseases at Colombo (Ceylon). From the Brambilla foundation for industrial prizes, awards have been made to Elia Bianchi, for his system of constructing dwelling houses formed of hollow concrete blocks, and to Renaldo Rossi, for whole-meal and anti-diabetes bread. The Fossati prize is awarded to Professor Giuseppe Sterzi, of Padua, for his two published volumes on the central nervous system of vertebrates.

PROFESSOR MAGNUS-LEVY, of the University of Berlin, has come to America to deliver the three Cartwright Lectures of the Alumni Association of the College of Physicians and Surgeons of Columbia University on April 11, 12 and 13. The subject of the lectures is "Some Phases of the Chemistry of Diabetes." He delivered a lecture before the Harvey Society on April 9 at the Academy of Medicine.

PROFESSOR F. E. LLOYD, of the Alabama Polytechnic Institute, lectured on March 28 before the faculty and students of the University of Alabama on "The Guayule, a desert rubber plant."

PROFESSOR E. L. THORNDIKE, of Columbia University, gave last week at the University of Illinois, five lectures on "Individual Differences and their Causes," under the joint auspices of the College of Literature and Arts and the School of Education. The subjects of the five lectures were: "Measurements of Individual Differences"; "The Influence of Sex"; "The Influence of Race"; "The Influence of Immediate Ancestry"; "The Influence of Training."

A MONUMENT to the memory of Horace Wells, who was the first to introduce the practise of painless dentistry with the aid of nitrous-oxide gas, was unveiled at Paris on March 27 in the Place des États Unis. The monument consists of a bust, supported by a white marble column to which has been affixed a medallion of the physiologist, Paul Bert, who perfected the method of the American

dentist. The ceremony was presided over by M. Dastre, who delivered an address on behalf of the Academy of Medicine.

PROFESSOR ROBERT PARR WHITFIELD, curator in the American Museum of Natural History since 1877, the author of important contributions to paleontology and geology, died on April 6, at the age of eighty-two years.

DR. BORDEN PARKER BOWNE, professor of philosophy and dean of the Graduate School of Arts and Sciences of Boston University, well known for his works on philosophy and theology, died on April 1, at the age of sixty-three years.

DR. HARRY WALKER JAYNE, of Philadelphia, an authority on coal-tar products, died on March 7, at the age of fifty-three years.

DR. RICHARD ABEGG, professor of chemistry at the University of Breslau, was killed, on April 4, in landing after a balloon ascension.

THE surgeon-general of the army announces that preliminary examination of applicants for appointment as first lieutenants in the army medical corps, will be held on July 18, 1910, at various army posts throughout the country. Full information concerning the examination can be procured upon application to the "Surgeon-General, U. S. Army, Washington, D. C." The essential requirements to securing an invitation are that the applicant shall be a citizen of the United States, shall be between 22 and 30 years of age, a graduate of a medical school legally authorized to confer the degree of doctor of medicine, shall be of good moral character and habits, and shall have had at least one year's hospital training or its equivalent in practise. The examination will be held concurrently throughout the country at points where boards can be convened. Due consideration will be given to localities from which applications are received, in order to lessen the traveling expenses as much as possible. The examination in subjects of general education (mathematics, geography, history, general literature and Latin) may be omitted in the case of applicants holding diplomas from reputable literary or scientific colleges, normal schools or high schools, or graduates of medical schools which require an entrance examination satisfactory to the faculty of the Army Medical School. Applications must be in possession of the adjutant general on or before June 27. There are at present 123 vacancies in the medical corps of the army.

THE Oceanographical Museum at Monaco, established by the Prince of Monaco, was opened on March 29. The different European governments and the principal scientific societies were represented at the ceremony.

THE University of Michigan Museum has received from an alumnus, C. A. Hughes, of Chicago, a collection of natural history specimens from British East Africa and an assortment of anthropological specimens from British East Africa, Uganda, Zanzibar, Zululand and other countries on the east coast of Africa. The mammals include: eland, topi, Jackson's hartebeest, wildebeest, bushbuck, waterbuck, wart hog, Coke's hartebeest, impala, Grant's gazelle, oribi, oryx, Petersi, steinbuck and Thompson's gazelle. Mr. Hughes was a member of the W. D. Boyce African Expedition, which invaded the interior of Africa with balloons and box kites for the purpose of making aerial pictures of game in the wild state, getting a photographic record of the topography of the country and pictures of the natives in their homes, and at work, hunting, play, etc. Besides Mr. Boyce, who personally led the expedition, and Mr. Hughes, there was a large staff of photographers. The expedition was entirely successful.

MOUNT SINAI HOSPITAL, New York City, announces the establishment of a second fellowship in pathology which will be known as the Eugene Meyer, Jr., fellowship. The income of the new fellowship, like that of the George Blumenthal, Jr., fellowship, established in 1908, is $500 per annum.

UNIVERSITY AND EDUCATIONAL NEWS

THE new general engineering building of Union College will be formally opened on April 28.

Mr. Milton C. Whitaker, M.S., general superintendent of the Welsbach's Company's works, has been appointed professor of industrial chemistry, at Columbia University, to the vacancy caused by the retirement of Professor Charles F. Chandler. Dr. Marston Taylor Bogert has been appointed to succeed Dr. Chandler as head of the department of chemistry.

At Harvard University, Dr. H. W. Morse, in physics, and Dr. L. J. Henderson, in biological chemistry, have been promoted to assistant professorships. Dr. W. R. Brinckerhoff has been appointed assistant professor of pathology and Dr. S. B. Wolbach, assistant professor of bacteriology.

Walter T. Marvin, A.B. (Columbia), Ph.D. (Bonn), preceptor in Princeton University since 1905, has been appointed professor of mental philosophy and logic in Rutgers College.

Dr. Arthur Willey, F.R.S., director of the Natural History Museum at Colombo, Ceylon, and marine biologist to the Ceylon government, has been appointed professor of zoology at McGill University. Dr. Willey, a graduate of Cambridge, acted for some years as tutor in biology in Columbia University.

DISCUSSION AND CORRESPONDENCE

AIR CURRENTS IN MOUNTAIN VALLEYS

To the Editor of Science: Mr. Varney's interesting account of the control of cliff shadows on air currents observed in the valleys of the Canadian Selkirks, which appeared in a recent issue of Science, prompts the following report of some facts of a similar nature noted in the Yosemite Valley.

The lay and configuration of the steep-walled Yosemite trough are such that at no hour of the day, even in mid-summer, are its two sides fully sunlit throughout: there are always cliff shadows here and there; while some dwindle, others grow. The effect of this alternation of light and shadow upon the air movements along the valley sides is most marked, indeed it fairly forces itself upon one's attention when traveling on any of the zigzag trails that lead up out of the valley. On a sunlit slope the dust from the horses' feet floats slowly upward in a golden cloud that accompanies the ascending traveler in a truly exasperating manner. On a shaded slope, the dust cloud pours at once over the edge of the trail, so that parties descending rapidly from zigzag to zigzag constantly meet their own dust wafting down upon them from above. Obviously, the logical thing to do, in order to have a dust-free journey, is to time one's ascent for an hour when the trail is in shadow, and one's descent for an hour when the trail is sunlit. This principle, after it was once understood, was indeed deliberately put in practise by the writer on all occasions when the choice of hour mattered little otherwise—always with the desired result. Some trails, like that to the Yosemite Falls, lie as a rule partly in sun, partly in shadow, and on them the trips were arranged so as to avoid the dust on those stretches where experience had shown it to be densest.

In the Yosemite Valley, as in many other mountain valleys, there is further a pronounced general air movement lengthwise through the trough, proceeding up valley in the day time and down valley at night. The rhythmic regularity with which it reverses in the early morning and in the late afternoon, was made strikingly manifest during the summer of 1905, when severe forest fires near the lower end of the valley sent up a generous volume of smoke in the otherwise pure atmosphere. Every morning the valley was clear, having been swept out, so to speak, by the nocturnal down-valley current, and the pall could be seen floating off to the southwest, down the Sierra flank. But, as the shadows in the valley trough began to shorten and progressively larger areas became insolated, a moment would soon come when the warm up drafts gained the upper hand, and the up-valley current would be inaugurated. Then, the smoke would creep up the valley, becoming denser by degrees, until by nine or ten o'clock one could scarcely see across from rim to rim. This condition would prevail all day, until with the lengthening of the shadows

in the late afternoon, the second reversal would be brought about. The down-valley current would then set in, taking the smoke back with it.

To the writer who was at the time engaged in the topographic survey of the valley this daily smoke invasion was, it may be imagined, a source of no little annoyance; for, while it lasted, it precluded all long-distance graphic triangulation across the valley, the only means whereby the host of peculiar cliff details, so characteristic of the Yosemite Valley, could be located. Nor was it a matter of a day or two; with a provoking regularity rendered possible only by the general absence of disturbing winds and cloudy skies, typical of the region, it continued for four long months with scarce an interruption.

No doubt intimately related to the rhythmic reversals of the lengthwise air current is the period of placidity of Mirror Lake. The surprised and usually vexed tourist who finds he must get up an hour before sunrise if he wishes to see the mirror at its best, little suspects that what he has undertaken to do really amounts to keeping an appointment with the early-morning reversal of the air current, and that punctuality on his part is vital because of the almost momentary briefness of the phenomenon. Yet such is actually the case. The stillness of the water surface sets in as the down-valley draft dies out; but as soon as a sufficient amount of cliff surface has been insolated in Tenaya Canyon, the upward movement becomes general, and a faint tremor once more steals over the lake. That its placidity is less perfect with the afternoon reversal is probably due to the relative suddenness with which that reversal takes place and the almost immediate strength of the downward currents in a narrow steep-walled chasm like Tenaya Canyon.

There is a certain appropriateness, finally, in likening the nocturnal down-valley current to a stream. For not only does it follow the bottom of the valley trough as a channel, but it also receives tributaries from the side valleys. In the case of the Yosemite Valley, the parallel is the more complete, as each tributary air current literally plunges, water-fall-like, from the mouth of its hanging valley. Few visitors to the valley, probably, are aware of the existence of these—shall we call them "air-falls"?—nevertheless they are by no means imaginary, as one may readily find out to his satisfaction by ascending either the Yosemite Falls trail or the Nevada Falls trail in the evening. The writer had occasion to do so many times in returning to his high-level camps above the valley, and the unpleasant memory of the chilling down drafts that poured upon him on these evening trips has not yet lost its vividness.

FRANÇOIS E. MATTHES

WASHINGTON, D. C.

THE EFFECT OF ASPHYXIA ON THE PUPIL[1]

OVER a year ago I reported[2] that CO_2 gas produced a practically maximal constriction of the pupil, both in the intact frog and in excised bulbi, and I stated that this behavior of the frog's iris was interesting because asphyxia in mammals produces chiefly dilatation. This latter statement gave surprise to Drs. C. C. Guthrie, F. V. Guthrie and A. H. Ryan and they write in a recent issue of SCIENCE[3] that "in all animals observed, only momentary or no dilatation of the pupil occurs during the first stage of rapid asphyxia (. . .), and that as a rule a *very marked constriction* of the pupil occurs during this stage." It must be noted that these authors speak only of the *first* stage of asphyxia, the stage of hyperpnœa, and do not mention at all the second and third stages, where true asphyxia has developed. Had they pushed their experimental investigations a little farther, they would have found the marked dilatation of the pupil which occurs in mammals during the second and third stages of asphyxia. This well-known dilatation of the pupil is more pronounced and

[1] A reply to Drs. C. C. Guthrie, F. V. Guthrie and A. H. Ryan. (From the department of physiology and pharmacology of the Rockefeller Institute.)

[2] *Amer. J. of Physiol.*, 1908, XXIII., p. xvi; see also report of a demonstration, *Proc. of the Soc. for Exp. Biol. and Med.*, 1908, VI., p. 49.

[3] SCIENCE, March 11, 1910, XXXI., p. 395.

more lasting than the transitory initial pupillary constriction, and for this reason I said in my brief notes that the mammalian pupil shows "chiefly" dilatation during asphyxia.

From the above it will be seen that there was no occasion for the surprise nor the original communication of Drs. Guthrie, Guthrie and Ryan.

JOHN AUER

THE ROCKEFELLER INSTITUTE FOR MEDICAL RESEARCH

FREE PUBLIC MUSEUMS

IN an interesting note in the February 11, 1910, copy of SCIENCE, Mr. Baker calls attention to the commendable policy of the Chicago Academy of Sciences, while commenting on Mr. Ward's statement of the liberal practise at the Milwaukee Public Museum, of having its museum open freely to the public, and shows that while the Milwaukee institution has been free to the public since 1905, the Chicago Academy of Sciences has been following that plan since 1894.

The Illinois State Museum of Natural History has been accessible to the public without charge for the last half century, thus preceding the afore-mentioned museums in this good work by many years. It now remains to hear from some museum which has been free to the public for a century.

Doubtless the time is speedily approaching when museums will be as free and as accessible as our libraries. The hours during which museums are commonly open, from nine to five, should doubtless be extended in order that working people might be accommodated. With the disappearance of the candle light period there is no insurmountable obstacle toward making the museums as attractive during the evening hours as during the day time.

The Illinois State Museum is visited possibly more largely by the people from the surrounding villages and towns than by the citizens of Springfield. Previous to the last four months the number of visitors were simply estimated, but during the last three months count has been kept and the number has averaged about 1,500 monthly. The highest attendance was recorded during the first week in last October, when within five days 11,866 people visited the museum.

When the state properly cares for this institution which has had so long and useful a history, and which has a mission of untold value to perform, it will be extensively patronized and amply justify the expenditure necessary to make it one of the most valuable of the free public institutions in the state.

A. R. CROOK

FACTS VS. THE ADVANCEMENT OF SCIENCE

IN his vice-presidential address before Section L, Professor Dewey took as his text the failure of science teaching to fulfill the prophecies of its priests; and he referred this failure to the custom of teaching science as information rather than as that method of using the mind which is necessary for the manufacture of knowledge. Both elements are essential parts of science; it is, however, important that we keep clearly in mind which aspect we mean when we speak of science-teaching, or of the advancement of science.

We all know that there can be no true science that does not rest solidly upon facts. But the thought must often occur to many of us that there is some danger, especially among the younger scientists, that we may become obsessed with an exaggerated sense of the value of facts as such. Is there not too much emphasis laid by many professors in charge of research students on the mere accumulation of observational, statistical or experimental facts, with too little attention to that side of science which concerns itself with those analytical and synthetic processes that convert facts into valuable ideas? It seems to me that this latter kind of work needs at the present time at least as much encouragement as the other. Of course, there is the possibility for "thinking" to degenerate into profitless speculation; but we are certainly as much in need of the results of thinking about the facts already accumulated as we are of more facts.

It was especially noticeable at the meeting of the association that the younger men pre-

sented facts to the various sections, while the older men gave a larger share of their attention to the analysis of facts accumulated by others, combining results from various sources for the bracing or demolishing of hypotheses. It may be claimed that the right to speculate has been earned by the professors through years of hard work, and it is true that judgment comes with years. But the question occurs to me whether what may after all be a rarer kind of ability is not unduly discriminated against by the custom of demanding of all candidates for higher degrees in science "contributions" that are essentially accumulations of new data. Do we not need to recognize that there are at least possible "contributions" of value for the advancement of science that do not consist chiefly of new facts?

BENJ. C. GRUENBERG

DEWITT CLINTON HIGH SCHOOL,
NEW YORK
January 1, 1910

WHY PAWLOW?

TO THE EDITOR OF SCIENCE: In the interesting address of Professor Howell's published in SCIENCE of January 21, 1910, I note a reference to the work of "Pawlow" on enterokinase. Perhaps it is too late in the day to protest against this spelling, but it seems to the writer that even should our physiologists concede their science to be "made in Germany," certainly our language is not. There are certain obvious rules for the transliteration of Russian names that have been in effect since such transliteration began to be done. But of late there appears to be a tendency to ape the Germans in this regard. Vladivostok now masquerades on many maps as Wladivostok. But if Pawlow, why not "Saratow," or "Orlow" or "Trepow" or "Popow"? Even *Minerva* which no one ever accused of being un-Teutonic in its make-up, uses the spelling Pavlov throughout. What reader of contemporary history would recognize the name of the famous Russian diplomat, Pavloff, if he read that one Pawlow was some time minister to Korea? Surely our orthography is bewildering enough as it stands without wantonly importing foreign absurdities into it.

J. F. ABBOTT

THE NORWOOD "METEORITE"

TO THE EDITOR OF SCIENCE: Professor Very in his second article on the Norwood "meteorite" (SCIENCE, March 18, 1910, pp. 415–418) states that I helped him identify some of the minerals in thin section. I did identify the minerals, but, as is apparent to any petrographer, I am in no way guilty of the extinction angles recorded by Professor Very, or of the novel method of determining the composition of the feldspar. The feldspar is labradorite, but I did not attempt to find its exact composition.

G. F. LOUGHLIN

SCIENTIFIC BOOKS

Die Bienen Afrikas nach dem Stande unserer heutigen Kenntnisse. Von Dr. H. FRIESE. Zoologische und Anthropologische Ergebnisse einer Forschungsreise im westlichen und zentralen Südafrika ausgeführt in den Jahren 1903–1905, mit Unterstützung der Kgl. Preuss. Akad. d. Wiss. zu Berlin von Dr. Leonhard Schultze. 2 Bd. 475 pp., 2 pll., 19 charts and 1 text. fig. Jena, Gustav Fischer. 1909.

In this monograph the noted melittologist, Dr. H. Friese, has brought together practically all that is known concerning the Ethiopian apifauna. The region covered is Africa south of a line drawn from Senegal to Abyssinia. In all, 777 species of bees are enumerated from this vast area. Fifty-three of these are described for the first time, and of the remainder the original descriptions are reproduced. The introductory portion of the work will interest the student of geographical distribution, since it contains a number of maps showing the ranges of some of the more characteristic genera of bees, both in Africa and in other parts of the world. The bees of Madagascar are not considered, because they are mostly of peculiar genera and have been adequately described by H. de Saussure in his

contribution to Grandidier's great work on the fauna and natural resources of that island. The numbers given by Friese for the apifauna of various countries are worthy of note. Germany is credited with 440 species, Hungary with 510, Tyrol with 380, Great Britain with 200, Sweden with 212, Algiers with 413. The number of described species for the world is estimated at 8,000, of which 2,000 belong to Europe alone. Thus it will be seen that the Ethiopian region, though it may actually possess as many as 1,000 to 1,200 species, according to Friese's estimate, has a much poorer apifauna than Europe. This bears out the author's statement that bees are not really tropical insects, but have their optimum area of speciation in the north temperate zone. An examination of the Ethiopian bees shows, moreover, that a very large proportion of the genera and species must have come originally from the palearctic region, the southernmost portion of which is formed by the Mediterranean and part of the Red Sea littoral of Africa. According to Friese, the Ethiopian region has received its palearctic component by immigration "from Egypt, which is purely palearctic, like Algiers and Tunis, over Sudan-Abyssinia to the Kilimandjaro and Meru, where we still find on the mountains at altitudes of 2,500 to 3,000 m. some purely European forms of *Halictus* and a species of *Andrena* (*A. africana*) which is very similar to *A. helvola* of Central Europe." There is a possibility that a similar immigration has taken place from the Mediterranean littoral into the Congo basin along the west coast of the continent.

The palearctic origin of the great bulk of the Ethiopian apifauna is furthermore attested by the fact that though it comprises many cosmopolitan and European genera such as *Xylocopa, Nomia, Anthophora* and *Megachile,* often represented by species that have a striking African facies, it nevertheless contains very few genera that occur nowhere else. As such endemic genera Friese cites *Polyglossa, Patellapis, Fidelia, Meliturgula* and *Eucondylops,* each of which seems to have a very restricted range. *Meliturgula* stands between the genera *Panurgus* and *Meliturga; Polyglossa* and *Patellapis* are primitive forms, the former belonging to the Colletine, the latter to the Halictine subfamily. *Fidelia* is a genus unlike any hitherto described in that it presents a singular mixture of Gastrilegid and Podilegid characters. *Eucondylops* is based on a parasitic species (*E. konowi*) which Dr. Hans Brauns discovered in the nests of the remarkable bees of the genus *Allodape.* This latter genus ranges over the Indo-Malayan region, Sunda Archipelago, New Guinea and a limited portion of eastern Australia, but it is represented by the greatest number of species and individuals in the southern half of Africa, which is therefore to be regarded as its true home. Brauns, as quoted by Friese, found that the species of *Allodape* "do not make cells and provision them like other solitary bees with food for the individual larvæ, but that the eggs and larvæ in all stages of development, the pupæ and callow bees are all found together simultaneously in the same cavity of a hollow twig, which may attain a length of 12 cm. The larvæ, which are unique among bees in having extraordinary foot-like appendages, with which they hold the food that is given them, are fed till they mature." These bees are, therefore, truly social and breed and fly throughout the year along the warm coast of Cape Colony. It is interesting to note that the parasitic *Eucondylops* is very similar to its host *Allodape,* so that it is to be regarded as having been derived from this genus. This kind of phyletic relationship has been noted between many other parasitic bees and their hosts, and we are now coming to believe that many parasitic ant genera are also derived from the genera of their hosts.

Friese shows that the Ethiopian apifauna is very rich in certain genera, which are not so well represented in many other parts of the world. Thus he records 162 species of *Megachile* and 61 species of *Xylocopa.* Other widely distributed genera, however, like *Andrena* and *Osmia,* are very poorly represented.

The social bees of the Ethiopian region comprise 29 species of *Trigona,* the honey bee and four of its subspecies and varieties (*Apis mellifica, A. unicolor-adansoni, unicolor-in-*

termissa, unicolor-friesei and the typical *unicolor*). The bumble-bees (*Bombus*) are absent from the Ethiopian region, though they are known to occur in tropical South America.

W. M. Wheeler

Quantitative Chemical Analysis, Adapted for use in the laboratories of colleges and schools. By Frank Clowes, D.Sc. (London) and J. Bernard Coleman, A.R.C.Sc. (Dublin). Eighth edition. Philadelphia, P. Blakiston's Son & Co. 1909. Pp. 565. $3.50.

This is a new edition of a well-known and very popular book. The first edition appeared in 1891, the seventh in 1905. This was reprinted in 1907 and again in 1908, and here is a new edition. What is the reason for this popularity? We find it on comparing this with other manuals, which are as a rule either general or special, those of the general type giving few special or technical methods, and those of the special type dealing with a single branch of analysis. In the present book the authors begin with very thorough instruction in general analysis and pass on to specialties, such as the analysis of gas, water, milk, butter, tanning materials, oils and fats, assaying, iron and steel, etc.

This comprehensive task is well done in this edition in 565 closely printed pages, by omitting matters theoretical, and thus gaining space. The directions for work are so clear and comprehensive that an isolated analyst should be able to overcome any difficulties with its help. For example, 10 pages are given to a thoroughly illustrated, very detailed but empirical treatment of the subject of the balance and weighing. Treadwell in his analytical chemistry gives also 10 pages to the subject, but half this space is given to mathematics and theory.

In brief the present volume will appeal less to the university-trained chemist, who has access to a library of books on analysis, than to the great number of analysts with only college or technical school training who need a well-written comprehensive book, which simply tells them what to do and how to do it.

Among the new methods described in the preface may be mentioned additional methods for the determination of melting and boiling points, for the electrolytic estimation of metals, for the volumetric estimation of hydrogen peroxide, formaldehyde, silver, tin and antimony in alloys and various new technical processes including the use of the bomb-calorimeter in coal valuation, and a new section on oils, fats and waxes to which Professor Lewkowitch has contributed.

E. Renouf

Elementary Chemistry. By Hollis Godfrey, Head of the Department of Science, Girls' High School of Practical Arts, Boston, Mass. Longmans, Green & Co. 1909. Pp. 456.

In the preface the author states that,

> Four ideals have governed the writing of this book. The author has desired to obtain simplicity; to reach the understanding of the student; to rouse the pupil to a realization that the science of daily life is identical with the science of the school room; to include all the essential facts and theories which could be rightly assimilated in one year's work in elementary chemistry. . . . No book which is a mere encyclopedia of facts arranged without reference to their teaching value can produce a maximum of effect. . . . It has been a constant purpose to bring forward wide-reaching general truths in the form in which they would most effectively impress the student.

In this book the author has followed a different path from the usual one and has produced a work which has much to commend it for the purpose for which it is evidently intended. Instead of confining himself to a rather detailed study of a few of the simple substances and preparing the way for a more advanced course, the author has had in mind the needs of those who will have no further opportunity to study this subject and has covered in a very general way the more important points in the fields of both inorganic and organic chemistry, emphasizing especially the application of this science to daily household life. Owing to the fact that this book would probably be used by students more advanced than those who would take an elementary

course as a preliminary to a more advanced one, the subjects can be treated in a more general and advanced form without, however, smothering the general principles in a multitude of details. One peculiar feature of this book which would probably attract the attention of a reader is the unusual method of introducing various subjects by what might be called a poetical reference to some action in the world at large as a basis to explain some chemical fact or hypothesis. While this appears, to the chemist who has been trained to reason on the basis of observed facts and to keep away as far as possible from unprofitable speculation, to be an unscientific method of treating the subject and one usually more suitable for primary grades, it may have its value, just as a study of models enables one to grasp more clearly the conception of stereochemistry and the configuration of molecules. On the whole, therefore, the reviewer considers that this book should be of value in introducing a class of girls to the part which chemistry plays in the affairs of the world surrounding them. J. L. G.

Die Normalen Asymmetrien des Menschlichen Körpers. By Professor Dr. E. GAUPP. Pp. i + 59, mit 8 Textfiguren. Jena, G. Fischer. 1909.

This little but useful volume forms a fourth part of a "Collection of Anatomical and Physiological Publications" written by Professors Gaupp and W. Nagel.

The present work is to a large extent a continuation of Professor Gaupp's former study concerning the right-handedness of man (No. I. of the same series of publications). It summarizes in a somewhat detailed manner the various observations recorded in anatomical and anthropological literature on such asymmetries of the different parts of the human body which are not due to disease, and at the same time it presents a thorough critical consideration of the many causes of these various inequalities.

A large part of the brochure is devoted to the asymmetries of the spine and to those of the limbs. The treatment of the inequalities in the different other parts of the osseous system is less comprehensive, and there is a lack of individual investigations by the author. Notwithstanding this the work will be very useful for reference to the student of the subject with which it deals, and will be further valuable by its large bibliography.

There could, perhaps, be found some fault with the term "normalen" in the title, for strictly speaking there are no *normal* asymmetries; but the author employed this term in want of something more expressive to denote that he is not dealing with the effects of pathological conditions. A. HRDLIČKA

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VII., No. 4, issued March 25, contains the following: "The Purin Ferments of the Rat," by Alice Rohdé and Walter Jones. Investigation of extracts of the tissues of rats failed to demonstrate either adenase or xanthoöxidase. Rats' urine, however, contains uric acid. The origin of this uric acid must be attributed either to the action of purin ferments *in vivo* which do not exhibit themselves in organ extracts or to processes which do not involve the known purin ferments. For the latter explanation, much experimental proof exists. "On the Salts of Cytosine, Thymine and Uracil," by Victor C. Myers. A description of the preparation and some of the properties of the sodium, potassium, mercury and lead salts of thymine and uracil. "The Presence of Iodine in the Human Pituitary Gland," by H. Gideon Wells. Analysis of human pituitary glands taken from subjects who had not received iodides while in the hospital failed to show iodine in the gland: similar analyses of glands from subjects who had received iodides revealed iodine in the pituitary gland. Hence the normal presence of iodine in the gland is unproved. "A Note on the Physiological Behavior of Iminoallantoïn and Uroxanic Acid," by Tadasu Saiki. Elimination of purins in the urine is unaffected, excretion of oxalic acid is increased by the administration of either of the above-mentioned substances. "Nylander's Reaction

in the Presence of Mercury or Chloroform," by M. E. Rehfuss and P. B. Hawk. Neither mercuric chloride nor chloroform interferes with Nylander's test for sugar performed in the manner described by these authors. "A Study of Nylander's Reaction," by M. E. Rehfuss and P. B. Hawk. A study of various methods of performing the test, its delicacy, the effects of temperature and the influence of a variety of substances upon it (drugs and urinary constituents). "Effects of Soluble Salts upon Insoluble Phosphates," by J. E. Greaves. Various salts such as sulphates, chlorides, nitrates of sodium, calcium, ammonium or magnesium may increase the solubility of the insoluble phosphates and so indirectly affect the growth of plants.

BOTANICAL NOTES

PAPERS ON TREES

THREE papers upon the hawthorns (*Crataegus*) have come to hand during the past few months. The first by W. W. Eggleston—"The Crataegi of Mexico and Central America" (*Torrey Bull.*, 1909)—describes the wild species and varieties of these countries, ten in number, of which four species and two varieties are here named for the first time. The author remarks that "the genus *Crataegus*, south of the United States, seems confined to the tablelands of Mexico, and southward through the highlands of the Andes. In Mexico the fruit is of much economic importance, being often found in the markets, and the trees are guarded as carefully as other fruit trees are with us."

The same author in a later number of the *Torrey Bulletin* under the title "New North American Crataegi," describes three new species from (1) Texas, (2) North Carolina, eastern Tennessee and southern Virginia and (3) Montana.

Professor Sargent has been studying the "American Crataegi in the *Species Plantarum* of Linnaeus" (in *Rhodora*, 1909) in the Plukenet Herbarium (British Museum), and in the Linnaean Herbarium. *Crataegus viridis* is identical with *C. viridis* of the southeastern United States. *C. crus-galli* can not certainly be identified with any of our species. Of *C. tomentosa* he says "it is not possible to guess even at the plant described by Linnaeus" under this name. *C. coccinea* is in such confusion that Professor Sargent abandons the name, and substitutes for it the name *C. rotundifolia*, var. *pubera*.

Ivar Tidestrom's "Notes on Populus, Plinius" (in *Midland Naturalist*, 1909) attempts to distinguish *Populus alba*, *P. canescens* and *P. alba bolleana*. His discussions and descriptions are made plainer by two plates.

Before leaving Vermont for Wisconsin Professor L. R. Jones completed with the aid of F. V. Rand a most useful paper on "Vermont Shrubs and Woody Vines" (Bull. 145, Vermont Experiment Station), including figures and descriptions of the smaller woody plants of his state. He enumerates 135 species, and this does not include any species of *Crataegus*, this genus being passed over with only a characterization of the "groups." The excellent and life-like cuts (by Mary Robinson) enable one to follow the text descriptions very easily. We wish here to record our conviction that bulletins of this kind, although not "agricultural" in the narrower sense, are very properly included among the publications of the Agricultural Experiment Stations, since they bring to all who are interested in trees and shrubs much information which must lie at the foundation of many "practical" investigations.

Professor Shimek discusses "A Hybrid Oak" (in *Proc. Iowa Academy of Sciences*, 1909) and by comparisons and figures shows it to be pretty certainly a hybrid of *Quercus imbricaria* and *Q. palustris*.

Allied somewhat remotely to the foregoing papers is H. H. Bartlett's article on "The Submarine Chamaecyparis Bog at Woods Hole, Massachusetts," in *Rhodora*, December, 1909. A photograph shows well the roots of trees that once grew at levels now covered at high tide.

Professor Shimek read a paper on "The Relation of Forestry to Engineering" early in

1909 before the Iowa Engineering Society (published in the *Proceedings* of the Society) which is a vigorous defense of the contention of the foresters that forests conserve the rainfall in such a manner as to materially affect stream flow. Beginning as a defense, the writer rapidly pushes his discussion into a smashing criticism of recent statements made in certain quarters as to the inefficiency of forests in holding back and lessening floods. The paper should be widely read at this time when concerted assaults are being made upon the efficiency of the forest cover.

Here we may notice Professor Bray's bulletin on "The Mistletoe Pest in the Southwest" (Bull. 166, Bureau of Plant Industry, U. S. Department of Agriculture). From it we learn that the American mistletoe (*Phoradendron flavescens*) extends through the southern states across Texas, New Mexico and Arizona to southern California, thence northward in the coast region to Oregon and Washington. In the east its northern limit is New Jersey, southern Pennsylvania to southern Illinois, Missouri and eastern Oklahoma. In Texas it attacks species of *Hicoria, Quercus, Ulmus. Celtis, Toxylon, Morus, Sassafras, Acacia, Prosopis, Gleditsia, Xanthoxylum, Melia, Sapindus, Nyssa, Diospyros, Fraxinus* and *Tecoma.* In commenting on this matter the author says: "It is a question whether any tree is wholly immune to attacks from the mistletoe." Much space is given to a discussion of the eradication of the pest. Two plates and several text illustrations add to the value of the bulletin.

Professor F. J. Phillips makes a valuable contribution to our knowledge of a peculiar injury to forest trees—namely, that due to hail-storms, in a recent paper—"Hail Injury on Forest Trees" (*Trans. Acad. Sci. St. Louis*, XIX., 3). By means of photographs the author shows the extent of the injury (often very great) to many kinds of trees. The direct injury is often supplemented by the advent of boring insects and wood-destroying fungi. Catalpa suffers the most, probably on account of its large leaves and somewhat succulent bark. Osage orange endures hail better than any other of the broad-leaved trees.

PLANT BREEDING

THAT the breeding of plants has become a reality may be inferred from the titles of a few recent papers, the contents of which are too technical to be outlined or abstracted here. Thus we have W. J. Spillman's "Application of Some of the Principles of Heredity to Plant Breeding" (Bull. 165, Bureau of Plant Industry, U. S. Dept. Agric.), covering 74 pages, with text, tables, diagrams and a full index. And next—E. M. East's "Distinction between Development and Heredity in Inbreeding" (*Am. Nat.*, 1909), followed by four papers by G. H. Shull, viz., "A Simple Chemical Device to Illustrate Mendelian Inheritance" (*Plant World*, 1909); "The Results of Crossing *Bursa bursa-pastoris* with *Bursa heegeri*" (Proc. 7, International Zool. Congress); "Inheritance of Sex in Lychnis" (*Bot. Gaz.*, 1910); "Color Inheritance in *Lychnis dioica* L." (*Am. Nat.*, 1910).

GENERAL NOTES

A YEAR or so ago Professor E. B. Copeland published as Bull. 24 of the Philippine Bureau of Education a suggestive pamphlet including first, an "Outline of a Year's Course in Botany in the Philippine Secondary Schools," and second, a "Key to the Families of Vascular Plants in the Philippine Islands." While especially helpful to the teachers on the islands, it will prove useful to many teachers in the United States.

Maiden and Betche's "Notes from the Botanic Gardens of Sydney, New South Wales," includes a number of descriptions of new species, and new localities of hitherto known species. Two good plates accompany the paper.

New parts of Karsten and Schenck's "Vegetationsbilder" (Gustav Fischer, Jena) include very different types of vegetation. Dr. Rikli, of Zurich, describes and beautifully illustrates the vegetation of Danish West Greenland, and F. Seiner, of Graz, does the

same for the dry steppes of the northern and middle Kalahari region in South Africa. The contrast between the two regions covered by these two Heften is most striking. The illustrations continue to maintain the high standard of excellence which they have shown from the beginning of the series.

Professor Hansen's bulletin on "The Wild Alfalfas and Clovers of Siberia, with a Perspective View of the Alfalfas of the World" (Bull. 150, Bureau of Plant Industry, U. S. Department of Agriculture) tells, first, of his several journeys into parts of Siberia, and then discusses quite particularly three Siberian alfalfas, viz., *Medicago falcata, M. platycarpa* and *M. ruthenica,* all of which are cultivated. Common alfalfa, *M. sativa,* and sand lucerne, *M. media,* are grown also, as are *M. glutinosa* and *M. arborea* (often 10 feet high) to a very limited extent.

Professor Gates attempts to make an analytical key to some of the segregates of *Oenothera* (Twentieth Annual Report of Mo. Bot. Garden), and succeeds in designating no less than twenty-two "species," beginning with *Oenothera biennis* of Linnaeus. The author finds it necessary to add one new species, *O. rubricalyx* which "originated as a mutant from *O. rubrinervis* two years ago." Surely we are making progress in regard to a practical acceptance of evolution!

"Some Unsolved Problems of the Prairies" are discussed, by Professor H. A. Gleason, in the *Torrey Bulletin* for June, 1909. He confines himself to the Illinois prairies where they "were converted into cornfields long before the development of ecology and phytogeography in America, thus forever prohibiting the satisfactory investigation of some questions of the most absorbing interest." The sources of information still available are enumerated, and then he discusses eight problems which have hitherto remained unsolved.

Allied to the last is Professor C. H. Shaw's paper on "Present Problems in Plant Ecology" in the *American Naturalist* for July, 1909, dealing very largely with those problems that develop in the study of alpine vegetation, including heat, precipitation, length of season, light and evaporation. Little more is attempted than the setting forth of the problems in a distinct form. At the close the author expresses the wish which every botanist will echo, "that some one whose knowledge of physics and physiology fits him for such a task should overhaul and scrutinize our ideas and methods," and a little later says "there can be no question that ecology at the present time contains not a little of discernible error." And to the latter there is a chorus of "amens" from scientific botanists everywhere.

The same author shows (in *Plant World,* August, 1909) that "timber-line" on high mountains is often due to the action of the snow.

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SPECIAL ARTICLES

ARTIFICIAL PRODUCTION OF MULTIVOLTINE RACES OF SILKWORMS

THE domesticated moths known as silkworms have been the subject of much interesting observation and experiment in recent years. The work of Toyama,[1] Coutagne[2] and particularly that of Kellogg[3] in this country, has added much to our knowledge of the hereditary processes revealed by the manifold varieties of this insect. In a recent study Miss McCracken,[4] continuing the previous work in Professor Kellogg's laboratory, has studied the heredity of the race characters, bivoltism and univoltism, in the silkworm. By the former term is meant the condition by virtue of which two broods are produced annually, whereas in the univoltine form, but one brood is reared, the eggs laid in the spring wintering over and hatching out the following spring. This racial character being a physiological rather than a morphological one, is of peculiar interest in heredity.

The elaborate breeding experiments of Miss

[1] *Bull. Agricultural Coll.,* Tokyo Imp. Univ., VII., 1906.

[2] *Bull. Scient. de la France,* XXXVII., 1903.

[3] "Inheritance in Silkworms," *L. S. Jr. Univ. Pub.,* 1908.

[4] *Jour. Exp. Zool.,* 1909, VII., 747.

McCracken extending over a period of five years seem to indicate that the character does not follow out the Mendelian ratio in hybridizing, but rather that the bivoltine character shows an increasing prepotence over the univoltine character in consecutive generations. Miss McCracken interprets this as a reversion to an ancestral condition.

One of the most significant results obtained by Tower in his work with *Leptinotarsa*,[5] consisted in so altering the nature of the germ plasm of his developing beetles by certain "stimuli" that a normally two-brooded form became five-brooded—a condition that was perpetuated in succeeding generations.

Somewhat along the same line, certain experiments carried out in Japan and recorded in an obscure journal[6] would seem to deserve recognition, if only because of their interest in connection with the above-mentioned work of Tower and Miss McCracken. As it is unlikely that this paper is either accessible or intelligible to the majority of occidental biologists, it may be worth while to give a brief abstract of it, in the hope that some one may be induced to repeat the rather uncritical experiments of the Japanese and thereby throw more light on the interesting phenomena of alteration of brood habit.

The article is entitled "The Artificial Production of Trivoltine Silkworms from Bivoltine," and the writer, Mr. K. Tsukai, begins by relating how an experienced silkworm grower named Matsumoto, living in a town of Shizuoka-ken, called Uragawa, brought some bivoltine silkworm eggs of a dealer some twenty miles to the north, intending to keep them over the winter and rear them the following spring. To his astonishment, after a few weeks, the eggs began to hatch. He thought at first that he had been tricked in his purchase, but on recollecting that the climate of his own town and that from which his eggs had come is quite different, he resolved to suspend judgment pending investigation. He found, indeed, that there was a difference of five or six days in the hatching interval in the two places, the worms which issue in twelve to thirteen days ordinarily, requiring there some eighteen days. Conceiving that a sudden temperature change might have occasioned this alteration in the physiological habit of his silkworms, he decided to experiment.

Near Takizawa is a famous cavern, the temperature of which varies little from 60° [Fahrenheit?] the year round. Within this cave he placed some eggs of the first brood of a bivoltine race, intending to delay their hatching until the eighteenth day. Eggs placed in the cave three days after laying and kept there nine days, on being removed, hatched out three days later, apparently unaltered by their stay in the cave. Next year (1903) he took up the matter again. Some bivoltine eggs were divided into two lots. The first were "brushed down" (first instar), March 31, pupated May 17 and emerged June 7. The eggs of these moths after a two-day interval were placed in the cave (March 24). After 13 days, *i. e.*, June 6, they were taken out. Six days later (June 12) they hatched. In rearing them, it was found that the cocoons were inferior to those of the second brood. The average cocoons of the second brood run about 270 to the *sho* (1.8 liters). These ran about 308. Of these only four or five revealed the trivoltine character.

The first brood of the second lot were "brushed down" April 15, pupated May 17 and emerged June 7. The eggs from these after a two-day interval were placed in the cave. After a stay of nineteen days (June 27) they began to hatch in the cave. The worms were "brushed down" and reared, but were very thin and "thread-like." Larvæ in the second moult average about 15.4 g. in weight. These did not exceed 10.5 g. They pupated July 23. The cocoons were very light and small, 358 of them bulking the same as 255 of the ordinary second brood.

Nevertheless, these all hatched out as trivoltine moths. Thus the experimenter's aim had been accomplished.

It is to be regretted that the Japanese writer does not give more explicit information as to

[5] Carnegie Pub., No. 48, 1906, p. 289.

[6] *Dai Nihon San Shu Kwai Ho* (Rept. of the Sericultural Assoc. of Japan), No. 171, p. 5, 1906.

the details of the third metamorphosis. Some of the specimens were given to the local sericultural school for experimental breeding, and by it distributed so that a number of silk growers in the vicinity are now rearing the trivoltine form.

The cave is described as lying in the south side of a mountain leading downward about 350 yards. The interior is moist and dripping. The temperature as mentioned before is 60°.

The larvæ were placed in a corner of the cave on the top of a "coal oil box" and enclosed in a double packing box (such as is used for storing treasures in go-downs). This box measured externally two feet square by one and a half feet high. The inner wall, one foot two inches square by about one foot high. The space between was filled with sawdust. (Apparently no record was made of the temperature of the interior of the box.)

In concluding, Mr. Tsukai remarks that some successful results have been recently reported in changing a trivoltine race into a quadrivoltine, presumably by the same method. He attributes the change to an inhibition of development through a lowering of the temperature. If so, it should be easy to reproduce the results described.

If it is true that the bivoltine races can be converted into trivoltine so easily, it would seem unlikely that the condition of bivoltism can be explained as a case of reversion.

J. F. ABBOTT

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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE SECTION B—PHYSICS

THE annual meeting of the American Association for the Advancement of Science, Section B, was held in Boston, beginning Tuesday morning, December 28, and closing Friday noon, December 31, with two sessions daily. All sessions except that on the closing day were joint sessions with the American Physical Society. That on Tuesday afternoon was participated in also by Section A, and that on Friday was a joint session with Section L. The presiding officers were Vice-president Bauer, of Section B, and President Crew, of the American Physical Society. All the meetings were held in the physics lecture room of Walker Building, Massachusetts Institute of Technology, except on Wednesday, when both sessions were held in Cambridge at the Jefferson Laboratory of Harvard University. The attendance was uniformly good, varying from one hundred to two hundred. Fifty-nine papers and addresses were presented at the meeting.

On Wednesday evening there was an informal dinner for physicists at the Hotel Vendome and on Thursday afternoon a reception was given to all visiting physicists and their ladies by President and Mrs. Maclaurin of the Massachusetts Institute of Technology, at their home. Both of these were well attended and greatly enjoyed. An informal dinner and conference of the officers of Section B and of the American Physical Society on Tuesday evening led to a satisfactory plan for a more complete cooperation of the two organizations and a better agreement with respect to the range of activity of each.

A short business session on Tuesday resulted in the selection of the following officers for the meeting next Christmas at Minneapolis:

Vice-president and Chairman of Section—E. B. Rosa, Washington, D. C.

Secretary—A. D. Cole, Columbus, O.

Member of Council—W. S. Franklin.

Sectional Committee—L. A. Bauer, E. B. Rosa, A. D. Cole, A. Trowbridge, A. P. Carman, G. F. Hull and E. L. Nichols.

Member of General Committee—F. P. Whitman.

Several new members were added to the section and fifty members were made fellows of the association.

At the joint sessions on Tuesday afternoon and Friday morning an effort was made to provide programs that would be of interest to others than physicists. The papers presented were wholly by invitation. The large audiences—approximately two hundred in each case—and the interest shown demonstrated the success of this effort and led to a decision to adopt the "general-interest session" as a permanent policy. The program on Tuesday was presented by Sections A and B jointly and that on Friday by Section B. These programs follow.

TUESDAY AFTERNOON, DECEMBER 28

Some Reforms needed in the Teaching of Physics (vice-presidential address of Section B): Professor KARL E. GUTHE, of the University of Michigan.

On the Determination of Latitude and Longitude in a Balloon: Professor C. RUNGE, of the University of Berlin.

The Ruling of Diffraction Gratings: Professor A. A. MICHELSON, of the University of Chicago.

On Certain Physical Hypotheses sufficient to explain an Anomaly in the Moon's Motion: Professor E. W. BROWN, of Yale University.

Professor Guthe's address has been printed in full in SCIENCE, January 7, 1910, and an abstract of that of Professor Runge is printed in SCIENCE for January 28 (Report of Section A). Abstracts of the other two are given below:

On the Ruling of Diffraction Gratings: A. A. MICHELSON, University of Chicago.

The difficulty with the echelon and other interferential methods of great resolving power lies in the large number of overlapping spectra. In the grating great regularity in spacing is required if high resolving power is sought. The use of the cadmium red line makes it possible to secure the needed regularity in spacing, since the alternations of dark and light interference bands can be observed through 250,000 wave-lengths.

After long labor it has been found possible to make gratings as efficient in resolving power as are the echelon and other interferential apparatus. An idea of the accuracy required is gained from the consideration that errors must not exceed .00001 inch when not systematic; if they are systematic much greater accuracy than this is necessary to avoid "ghosts," say to .000001 inch. The best screws when they come from the lathe have errors of about .001 inch. By grinding, say a month, with a special nut, these can be reduced to about .0001, and by further labor to .00002 inch. Beyond this, local processes of correction become necessary.

To secure gratings of sufficient length for the great resolving power desired, it was necessary to use a screw three times as large as that used in Rowland's machines. His method of grinding was tried for a long time without securing satisfactory results. By the use of a grinding nut cut into three parts and with very fine emery success was finally reached. The use of too coarse emery in order to save time caused the wearing out of one screw before its errors were removed. Attempts to grind under oil and under water were made, but given up. Finally the following method was used: grinding for several months with the nut kept wet with soap and water; errors were then determined with the interferometer; then a correcting nut with an arrangement for rubbing harder on one side of the thread than the other was applied. In this way the errors were brought down to about .000002 inch. (The method for the final correction was also described.)

To work in the second-order spectrum 250,000 lines, or a grating fifteen inches long, was needed. To secure necessary rigidity in a screw long enough to rule this length, it must weigh thirty or forty pounds. Nine tenths of this weight was sustained by floating on mercury. Steel can not be used for the nut; a yielding material is required. Wood was used, as by Rowland. As great accuracy of ways is necessary, one bearing surface only was used instead of four as in a lathe. Great trouble was found in securing suitable diamonds for ruling. No difficulty was found the first year, after that not a good one was found for six years. Finally through Sir Wm. Crookes a satisfactory diamond was obtained from a certain mine which yields extra hard stones. To prevent undue wear very light pressure only on the tracing point was used, and the ruling subsequently deepened by etching. Only flat gratings have been ruled, as these can be made of higher accuracy than concave gratings.

On Certain Physical Hypotheses sufficient to explain an Anomaly in the Moon's Motion: ERNEST W. BROWN, Yale University.

Newcomb has shown that there is a difference between the observed and theoretical positions of the moon which can be roughly represented by a term of period about 270 years and coefficient 13".

In the paper the author has examined numerous hypotheses sufficient to explain the term, in order to clear the ground of those which seemed to be of doubtful value and to bring forward those which appeared sufficiently reasonable to merit tests from observations of a different nature. Some account of three of these hypotheses was presented to the meeting. It was stated that a minute libration of the moon would be sufficient, provided it took place in the moon's equator and had the proper period. The supposition of magnetic attraction practically demanded (*a*) a periodic change in the magnetic movement of the earth or of the moon. If (*a*) were rejected, it was necessary to suppose that the mean place of the lunar magnetic axis was near the lunar equator and that the oscillations of its position took place in the plane of the equator. The observed secular change of the earth's magnetic axis could not

produce the phenomenon without demanding a larger motion of the lunar perigee than observation warrants. On the border line between two sets of hypotheses was a curious fact, namely, that if the period of the solar rotation coincided very nearly with one of the principal lunar periods a minute equatorial ellipticity of the sun's mass was sufficient to explain the term. So far as known, these hypotheses do not conflict with any observed phenomena, but they cause some theoretical difficulties.

PROGRAM OF THE JOINT SESSION OF SECTION B AND SECTION L, FRIDAY MORNING, DECEMBER 21

The Relation of Colleges to Secondary Schools with respect to Physics: Professor E. H. Hall, of Harvard University.

What Specialization has done for Physics Teaching: Professor John F. Woodhull, Teachers College, Columbia University.

The Quantitative Teaching of Kinetics in Secondary Schools: N. H. Black, of Roxbury Latin School, Boston.

The Place of "g" in High School Teaching and other Topics: Professor A. G. Webster, of Clark University.

College Attitude toward Preparatory Work: Professor C. R. Mann, University of Chicago.

These papers were followed by an animated general discussion in which the following educators participated: Professors Guthe, of the University of Michigan; Hall, of Harvard; Franklin, of Lehigh; President McNair, of Michigan School of Mines; Professors Webster, of Clark; Woodhull, of Columbia; Mann, of Chicago; Hull, of Dartmouth; Rosa, of the Bureau of Standards, and Slate, of the University of California.

At the joint sessions of the American Physical Society and Section B, the following forty-nine papers were presented. Abstracts of many of these papers may be found in the February number of the *Physical Review* and others may be expected in later numbers of the same periodical.

Temperature Coefficient of Electrical Resistance—Tungsten, Molybdenum, Nickel and Nichrome: A. A. Somerville.

The Flow of a Gas through a Capillary Tube: Willard J. Fisher.

Effect of Surface Tension upon a Falling Jet of Water: F. R. Watson.

The Variation of the Hall Effect in Metals with Change of Temperature: Alpheus W. Smith.

The Effect of Pressure on the Electrolytic Rectifier: A. P. Carman and G. J. Balzer.

The Analysis of the Principal Mercury Lines by Diffraction Gratings and a Comparison with the Results obtained by other Methods: Henry G. Gale and Harvey B. Lemon.

The Spectra of some Gases in the Region of Extremely Short Wave-length: Theodore Lyman.

The Variation of the Hall Effect with the Temperature in the Case of the Principal Magnetic Metals: Thomas C. McKay.

The Rectifying Effect in Point and Plane Discharge: Robert F. Earhart and Chas. H. Lake.

Photographic Photometry, and some Interesting Photographic Phenomena: Charles F. Brush.

Note on "Changes in Density of the Ether, and some Optical Effects of Changes in Ether Density": Charles F. Brush.

The Tone Quality of the Flute: D. C. Miller.

An Instrument for Projecting and Recording Sound Waves: D. C. Miller.

The Magnetic Measurements on Board the "Carnegie" in 1909: L. A. Bauer.

The Relativity Dilemma: D. F. Comstock.

"Bound Mass" and the Fitzgerald-Lorentz Contraction: Will C. Baker.

Physical Properties of Binary Liquid Mixtures: J. C. Hubbard.

On the Use of Polar Coordinates in Thermodynamics: J. C. Hubbard.

The Theory of the Vibration Galvanometer: F. Wenner.

Coefficients of Linear Expansion at Low Temperatures: H. G. Dorsey.

The Freezing of Mercury at High Pressures: P. W. Bridgeman.

Phenomena of Spark Discharge through Wire Conductors: Francis E. Nipher.

Some Minute Phenomena of Electrolysis: H. W. Morse.

A New Method of Measurement of Small Angles: C. W. Chamberlain.

The Photographic Evidence for Dispersion of Light in Space—Is it a purely Photographic Phenomenon? H. E. Ives.

On the Secondary β Radiation from Solids, Solutions and Liquids: S. J. Allen.

The Effect of Filter Paper upon the Mass and Form of the Deposit, in the Silver Coulometer: E. B. Rosa, G. V. Vinal and A. S. McDaniel.

Experiments in Impact Excitation with the Lepel Singing Arc: George Nasmyth.

On the Coefficients of Diffusion of the Emanation and the Active Deposit Particles of Actinium: J. C. McLennan.

On the Relative Numbers of Positive and Negative Ions present in Atmospheric Air: A. Thomson.

Note on the Cause of the Discrepancy between the Observed and Calculated Temperatures after Expansion in the Space between the Plates of a Wilson Expansion Apparatus: R. A. Millikan, E. K. Chapman and H. W. Moody.

Some New Values of the Positive Potentials assumed by Metals under the Influence of Ultraviolet Light: R. A. Millikan.

The Second Order Effect of Ether Drift on the Intensity of Radiation: A. Trowbridge and C. E. Mendenhall.

The Rotary Dispersion of Quartz at —190° C. and Observations at other Temperatures: F. A. Molby.

The Pyrheliometric Scale and the Solar Constant: C. G. Abbot.

Single-line Series in the Spectra of Ca and Sr: F. A. Saunders.

The Relative Motion of the Earth and the Ether: H. A. Wilson.

A Study of the Multiple Reflection of Short Electric Waves between two Reflecting Surfaces: L. E. Woodman and H. W. Webb.

A Hot Air Engine Indicator Diagram: A. G. Webster.

The Nitrogen Thermometer from Zinc to Palladium: A. L. Day and R. R. Sosman.

On Calcium Clouds in Space: Dr. Stifer (presented by Percival Lowell).

The Second Postulate of Relativity: R. C. Tolman.

The Terminal Velocity of Fall of Small Spheres in Air: John Zeleny and L. W. McKeehan. (By title.)

The Present State of our Knowledge concerning Permanent Magnetism: A. A. Knowlton. (By title.)

The Heat of Dilution of Aqueous Salt Solution: F. L. Bishop. (By title.)

Uranous and Uranyl Bands—A Very Fine Band Absorption Solution Spectrum: W. W. Strong. (By title.)

Insulation of Observatory Domes for Protecting Telescopes and other Apparatus against Extremes of Heat and Cold: David Todd. (By title.)

On the Free Vibrations of a Lecher System: F. C. Blake and Chas. Sheard. (By title.)

Thunderstorm Electricity: W. W. Strong. (By title.)

Alfred D. Cole,
Secretary

Ohio State University

SECTION L—EDUCATION

The Boston meeting of Section L was unusually successful. The attendance varied from 50 to 110. The policy of the section of devoting each session to a single topic was again carried out. The section committee has voted to continue this policy for future meetings. President A. Ross Hill, of the University of Missouri, was elected the vice-president of the section and Professor John Dewey, of Columbia University, was elected member of the sectional committee.

Probably the most important contribution to the meeting was the address of the retiring vice-president, Professor Dewey, on "Science as Method and as Information." With great clearness it was pointed out what results follow from considering science merely as information and from teaching it accordingly. Only when science is studied as a universal method of obtaining knowledge will science take the important place that is now awaiting it in educational work. The paper has been printed in full in Science for January 28.

The first session of the section was devoted to a discussion of the topic, "Formulated Scientific Problems in General Education." The first speaker was Professor Edward L. Thorndike, of Columbia University.

He showed that a scientific treatment of education demands means of measuring the facts, changes and relations with which education is concerned. Some useful units of measure and scales for measuring are furnished by physiology, psychology and allied sciences. But in such cases as amount of knowledge of a language, degree of ability in English composition, quality of handwriting, improvement in manners or morals and the like students of education should devise units of measure and arrange scales for teachers. Any product or response or quality which varies in amount can be measured even though it is complex, subtle and subject to an enormous effect from the personal equations of observers.

The desiderata in a scale for the measurement of educational facts are: (1) that the points on the scale be defined with exactitude, (2) that a difference of one should have the same value no matter where on the scale it occurs, (3) that the values attached to points on the scale should all refer to a defined and useful zero, preferably one signifying no amount whatever of the fact in question, and (4) that the scale be convenient

and fine enough. The speaker showed portions of a scale for the quality or goodness of handwriting in the case of children ten to sixteen which approximately realized these desiderata. The method of securing such a scale was explained.

Professor Charles H. Judd, director of the School of Education of the University of Chicago, presented some suggestions of experiments in education. Professor Judd pointed out that many tests have been proposed by committees and individuals in the hope of providing a means of collecting from large numbers of persons data which can be made the basis of elaborate studies of individual differences. These tests have been of little general use and the comparisons which they permit are of doubtful value. One of the chief reasons for this failure of tests is, I believe, to be found in the fact that they deal with the products of mental development rather than with the processes by which mental development is attained. Thus to take a concrete case, many tests have been made of the ability of individuals to reproduce a line exposed to inspection for a short interval. The ability to reproduce such a line is the product of a long series of experiences in which an indefinite variety of favorable and unfavorable conditions are involved. A single test can no more throw light on the mental complex which is involved in the reproduction of a line, than a single inspection of the external aspect of an animal can throw light on the process of organic evolution. What is needed is a test which shall bring out a succession of efforts to produce the line.

A second general type of test which I believe could very advantageously be tried on a large scale would be directed toward the solution of the problem of the different interests of children at their different ages. Let different types of material be presented to the whole school on such a general occasion as the general assembly, and let each child get as much out of the material presented as he can. Then let all the school be called on to write on what was seen or heard. To make this recommendation concrete, let one such demonstration be devoted to the explanation and exhibition of a simple scientific test of specific gravity, or the center of gravity. Let a second consist in a purely imaginative description calling upon the child for the exercise of visual imagery.

Finally, I have a general suggestion which, I believe, might properly be laid before this section. Many teachers are trying elaborate experiments in one subject or another and need help on the methods of testing their experiments. Thus a teacher is using the natural method, another the grammatical method, of teaching modern languages. Some teachers are trying the method of teaching geometry through concrete demonstrations rather than the conventional Euclidean logical demonstrations. The student of education needs only to go to the meetings of modern language teachers and teachers of mathematics to hear discussions of many such experiments. What is needed is the collection of all these experiments so that we may be intelligent as to the tendencies of actual practical school experimentation. Section L could, in my opinion, render no greater service than to organize a movement for the generalizing of such educational experimentation.

Professor George H. Mead, of the University of Chicago, presented a paper on "The Psychology of Social Consciousness" implied in instruction. The paper will be printed in full in SCIENCE. Its argument is as follows:

Primitive education is actually studied by that form of psychology which is termed social, because primitive education gathers about play, imitation and the reaction of adolescent emotion into initiatory ceremonies. On the other hand, the psychology which has scientifically studied the education in our modern school-systems has been largely intellectualistic, it has studied the subject matter that the child is to learn only from the point of view of the material in the mind of the child, of the associations by which it can be taught, and by the repetition of which it can be held in the child's mind. Thus the material of instruction and its acquirement is entirely separated from the social situation and its consciousness, which is implied in the relation of the child to his teacher, to the other children in the school, to the family that sends him to school, and to the society as a whole which is educating him to become a citizen. To the fact that the modern school has ignored to such a large degree the social nature of the child in the process of his schooling can be traced most of the admitted defects in methods of teaching. Actually both the form of instruction is social, *i. e.*, language which is the vehicle of converse between social selves; and the subject matter, *i. e.*, the material toward which our socially organized impulses, and the attention which is dependent upon them, are directed. Neither this form nor the subject matter of instruction can be scientifically con-

trolled unless we frankly recognize their social nature, and that of the children who are to be instructed. In this sense, if in no other, the scientific study of education implies a social psychology as a technique.

Professor W. F. Dearborn, of the University of Chicago, discussed "Problems in the Psychology of Reading."

A fundamental problem in education is that of finding ways to estimate accurately the rate of progress of pupils in their school studies—accurate tests are of value not only for measuring individual progress, but as a means for determining the relative merits of different methods of instruction. The test to which I wish to call your attention furnishes a means for estimating individual progress in learning to read—and thus affords a basis for judging of the success of the methods of instruction employed in teaching reading.

I assume your acquaintance with the general fact that there is among the physiological basis of reading, a peculiar form of movement of the eyes, of which the principal features are several distinct stops or pauses in each line that is read, with very rapid movement between pauses. This habit must be acquired just as any other, as, for example, the coordination of movements in learning to write, although we have not established the aids to its acquisition which exist in the case of handwriting. In fact, from the standpoint of the movements concerned we are not at all certain as to what constitutes good form in reading.

Some investigations of the qualities of merit in teachers were presented by William C. Ruediger, assistant professor of educational psychology in the George Washington University, Washington.

The following fourteen items of information were secured from twenty-six elementary schools: (1) the teachers by grades, numbered consecutively; (2) the highest certificate, diploma or degree held; (3) experience in years; (4) general merit; (5) health; (6) personal appearance; (7) initiative or originality; (8) strength of personality; (9) teaching skill; (10) control or ability to keep order; (11) ability to carry out suggestions; (12) accord between teacher and pupil; (13) progressive scholarship, and (14) social factor outside of school.

Beginning with the fourth item, the teachers were arranged by numbers in their order of merit, and the various items were correlated with general merit, by the Woodworth method of per cent. of displacement. The average per cents. of displacement obtained were for (3) 32; (5) 48; (6) 40; (7) 25; (8) 27; (9) 23; (10) 22; (11) 31; (12) 31; (13) 28; (14) 36. (7) compared with (11) gave an average displacement of thirty-one per cent. (8) compared with (12) gave an average displacement of 32 per cent. The best teachers had taught an average of fourteen years and the poorest eight years. No teacher ranked first or second had taught less than five years. 69 per cent. of the best teachers were found in the four extreme grades, while 57 per cent. of the poorest were in the four intermediate grades. Of the normal school graduates 28 per cent., of certificated teachers 21 per cent. and of college graduates 17 per cent. occupied first and second rank. The corresponding percentages for the two lowest ranks were for the normal graduates 16 per cent., certificated teachers 21 per cent., high school graduates 36 per cent. and college graduates 44 per cent.

The second session was devoted to a discussion of "Scientific Studies of the American College." The first speaker, Mr. E. C. Sage, assistant secretary of the general education board, discussed the "Geographical Location and Sphere of Influence of Colleges in the United States," as follows:

From the planting of Harvard College in Cambridge, Mass., in the year 1636, to the founding of the new college in Portland, Ore., in the autumn of 1909, the increase of colleges has kept pace with the westward movement of the population. The selection of sites for the location of colleges seems to have been made with slight regard to the existence of other institutions; for example, in and about Los Angeles, Cal., there are six colleges; in the Willamette Valley, Ore., a territory fifty by one hundred and thirty miles, there are seven colleges; in Kansas there are twenty-five colleges; in Iowa there are twenty-nine colleges; in Ohio there are no fewer than fifty-two institutions empowered by law to grant the bachelor's degree. A part of the Missouri Valley extending a distance of two hundred and fifty miles across the state of Missouri seeks to support nineteen colleges. Pennsylvania, with twenty-nine colleges, maintains eleven in her western range of counties, while Nebraska in her southeastern section, in a territory with a radius of fifty miles, has nine. In at least seven states it is possible to find as many as ten colleges in a territory circumscribed by a circle with a radius of fifty miles.

"National" Colleges.—The number of colleges, including the departments of arts and sciences of universities, which receive at least two students from at least twenty-five states, is fifteen. Of these, five are colleges for women only, five for men only, and five are coeducational. While these are designated as "national," a large proportion of their students come from a local territory, the proportion from within fifty miles ranging from twenty-three per cent. to fifty-five per cent.

Southern Colleges.—There are five southern colleges which enroll at least two students from each of ten southern states.

State Universities.—Naturally enough, most state universities serve principally the respective states in which they are located. There are three conspicuous exceptions; namely, the University of Michigan, with forty-one per cent. of its students coming from beyond state lines; the University of Virginia, receiving forty per cent. of its students from outside states, and the University of Wisconsin, enrolling nineteen per cent. of its students from beyond state boundaries.

The state universities, as a rule, serve widely their respective states; for example, the University of Indiana draws two or more students from ninety of the ninety-two counties of the state; the University of Illinois, from seventy-three of the one hundred and two counties of the state; the University of North Carolina, from sixty-seven of the ninety-seven counties of the state.

Colleges and States.—A survey of institutions, state by state, discloses the fact that only a few colleges in each commonwealth secure students in any considerable numbers from all parts of the state; for example, in the following eleven states the number of colleges which have two or more students from one half of the counties of their respective states are: Virginia, none; North Carolina, three; Georgia, none; South Carolina, three; Florida, none; Tennessee, none; Pennsylvania, one; Ohio, two; Indiana, two; Illinois, three; California, two. Of these fifteen colleges, six are state institutions.

The New England Colleges.—The colleges of New England differ from those found where the states are large. Nearly all receive students from all counties of the states in which they are respectively located, but when the field surveyed is narrowed to a radius of fifty miles many of the colleges are as local as any found in the United States; for example, fifty per cent. of the students of Bowdoin College are from within fifty miles; Harvard College, fifty-two per cent.; Bates College, fifty-six per cent.; Brown University, sixty-two per cent.; University of Vermont, sixty-five per cent.; Boston University, eighty-one per cent. Yale receives thirty-two per cent. of her students from New England and twenty-seven per cent. from New York State, making fifty-nine per cent. from New England and New York State. Dartmouth receives sixty-seven per cent. from New England. Other New England colleges are even more local.

General Conclusions.—From studies similar to those indicated above, general conclusions are drawn as follows:

1. A few colleges, numbering less than twenty, may be properly designated as "national," but even those so-called "national" colleges receive but a small proportion of their students from distant parts of the country.

2. A few southern colleges, numbering not more than five, serve in a large way the southern states, but these, likewise, are largely local.

3. The state universities, with two or three exceptions, are local within the state; but while drawing few students from without, they secure students from large portions of the state in which they are respectively located.

4. A very few of the private institutions are found which draw two or more students from one half of the counties of the state in which they are located. Several states have no such colleges.

5. All other institutions are emphatically local. When these colleges are located in a city or town of considerable size, one fourth to one third of the students are from the town or city and from fifty to eighty per cent. are from the immediate vicinity.[1]

Professor George D. Strayer, associate professor of education in Columbia University, presented the following data collected by a special inquiry of the bureau of education, from 93 colleges concerning the student body in American colleges.

In comparing the size of freshman, sophomore, junior and senior classes it is found that the median per cent. of the freshman class found in the sophomore class is 71 for men, 65 for women.

The junior class shows 55 per cent. of the freshman class as a median for men and 44 per cent. as a median for women. On the same basis the median for the senior class for men is 46 per cent. and for women 42 per cent. The median age for graduation for men is 23 years and one month.

[1] The estimates are based upon the enrollment of students in the four classes of the department of arts and sciences.

The median ages of graduation for the middle 50 per cent. of the colleges are included within the limits, 22 years and 6 months, 22 years and 9 months. For women the median age is 22 years and 8 months, the middle 50 per cent. falling between the limits 22 years and 23 years and 3 months.

The economic status of college students may be roughly indicated as follows: 19 per cent. have fathers who are engaged in professional work; 15 per cent. have fathers who own farms worth more than $5,000; 7 per cent. have fathers who own smaller farms; 20 per cent. have fathers engaged in trade or commerce, making more than $2,000 a year; 15 per cent. have fathers who make less than $2,000 a year in trade or commerce; 6 per cent. have fathers who are skilled laborers; 3 per cent. have fathers who are unskilled laborers, and the fathers of 15 per cent. of the students are dead.

Further light upon the economic status of students is shown by the fact that 25 per cent. of the student body engage in gainful employment for from four to twenty-four hours or more, per week, while in college.

Mr. Clarence F. Birdseye, editor of the new journal, *The American College*, and director of the Higher Education Board, spoke on the purposes of that association. Mr. Birdseye explained how the life of the student is lived upon three distinct planes; the statutory or the governmental plane, wherein the written law defines, commands or forbids certain rights, duties and acts; the contract or community plane wherein contracts, more or less formal, govern his relations with his fellows; and lastly, the home plane, wherein the parent enforces his commands under quite a different law from that of the other planes. The college used to pay considerable attention to the development of students on the home and the community planes, but now has centered all its efforts on the statutory or governmental plane. The new college and new style of learning required constantly more money for new buildings and a larger faculty. It gradually abandoned its home functions and centered its attention on the curriculum with a corresponding loss of its power to build up strong character. The college also offers no opportunity for recognizing unusual power or successful work by instructors. The Higher Education Association believes that the colleges need standardizing of efficiency and that this must come through radical changes in the college administration.

Extracts were read from the charter of the association to show how this would be done. The paper will be printed in full in SCIENCE.

Professor Wm. G. Hale, professor of Latin at the University of Chicago, presented a paper on "Problems in Grammatical Terminology."

The third session of the section was devoted to the report of the committee on the distribution of students in college courses.

Professor E. L. Thorndike, as chairman of the committee appointed to collect facts concerning (1) the practise of American colleges with respect to the number of students taught in one group by one instructor, and concerning (2) the studies actually taken by individual students to fulfill the requirements for the bachelor degree, presented the following data: (*a*) a list of the colleges which report in print more or less adequately the provision for teaching each course offered, and the number of students enrolled in it; (*b*) a table of frequencies of classes of different sizes in some twenty institutions, a class being defined as a group dependent on one person for their instruction in the subject; (*c*) a statement of the variation amongst institutions in the size of class in certain instructive cases, such as the first course in history, the first course in psychology, the first and second courses in French and German; (*d*) the per cent. of the total degree requirement given by each student to each subject in the case of some five hundred students from sixteen institutions; (*e*) measurements for the frequency of specialization in each institution; (*f*) measurements of the frequency of superficiality or scattering in each institution.

The following resolutions were presented by the committee and adopted:

Resolved, That samples of the facts concerning the number of students taught by one instructor be sent to the colleges and universities on the list of the United States Bureau of Education.

Resolved, That those in charge of collegiate instruction in each of these institutions be requested to report in print or to this committee any facts concerning the relation of the size of class to efficiency in teaching, with special reference to the following questions:

1. Is not the number of students taught at one time by a single individual in many college courses so great as to reduce that individual's knowledge of the attitude, preparation, difficulties, errors and achievements of his students to almost zero?

2. Is not the number of students taught at one

time by a single individual in many college courses so small as to involve an enormous waste of the instructor's time and an improper distribution of the appropriations for teaching?

3. Other things being equal, should not the teaching of more than forty college students at one time by one person be avoided? Should not any department have reasons of weight for any such case?

4. Other things being equal, should not the use of a quarter or more of a professor's teaching hours for a year for the instruction of fewer than ten students in one undergraduate course counting one twentieth or less of the degree's total requirement be avoided? Should not any department have reasons of weight for any such case?

5. Should not the traditional method of having the ratio which the number of class meetings is to the number of "points" credit the same, regardless of whether the class enrollment is 1, 5, 10, 20 or 100, be abandoned in many of the undergraduate courses enrolling less than ten students?

6. When, in a college course given annually, the number of students is less than 6, should not the course be offered only once in two years, except for reasons of weight?

Resolved, That those in charge of collegiate education in the colleges and universities on the list of the United States Bureau of Education be requested to consider the advisability of reporting for 1910, and once in every ten years thereafter a detailed statement of the work done for the bachelor's degree by each member of the graduating class or by each of 100 students chosen at random from it.

Beside these three sessions, several joint sessions were held with other organizations. The first of these with the American Federation of Teachers of the Mathematical and Natural Sciences was devoted to the presentation of reports and to a discussion of the work of the International Commission on the Teaching of Mathematics. This session is reported in full in the federation report.

The second joint session was held with the Social Education Club of Boston. The topic of this session was "Equal Opportunity for All."

The third joint session was held with Section B, Physics, for the discussion of the teaching of elementary physics. The report of this meeting will be found in the report of Section B. From the point of view of Section L the meeting had two significant features. The first was that one of the other sections of the association found it desirable to devote one of its sessions to a discussion of the teaching of science, and the other was the wide divergence of opinion expressed at the meeting. It is a hopeful sign that this discussion has been begun and it is certain that the diversity of opinion will gradually disappear if similar sessions may be held at succeeding meetings.

On Wednesday evening the Social Education Club of Boston held a public meeting. At this meeting Mr. Edward L. Stevens, associate superintendent of schools of New York City, presented a significant paper on "Why do Pupils leave the High School before Graduation?" Mr. Stevens's conclusions, based on a careful investigation of a large number of schools, are as follows:

1. Many students enter high schools who do not intend to remain after the age of sixteen or after they secure employment. Of 450 girls entering one of our high schools, about 130 were in this class.

2. Many students find, or think, during the first or second year of the course, that the work they are doing is in no wise calculated to prepare them to work or to work efficiently. I think it may safely be admitted that a year of Latin will be of little, if any, use to a boy who leaves at the end of the first year to enter a trade.

3. Many students of rather mediocre ability find that a course determined largely by college entrance requirements is either too difficult or does not appeal to their abilities or interests.

4. Many students are forced, unwillingly, to leave and go to work by the accidents or embarrassments met by their parents in business.

5. Many students are tempted to leave by the offer of employment at apparently alluring wages.

6. Some students leave because of the severity of the management or of the rigors felt at the hands of university-trained specialists.

7. Some students die, and a considerable number, particularly girls, break down or fail in health. A few girls marry.

The remedial measures suggested are stated in the conclusions which follow:

1. The training of children begins in the home. It should continue in the home. Girls and young women should have a training such that they shall become intelligent and efficient mothers, not only in order to preserve their own health and usefulness, but in order that they may bring up their children. The high school must in this respect, as in others, do much of the work for-

merly done in the home. The home is transferring constantly some of its functions to the school.

2. Many kinds of schools and many kinds of courses should be offered.

3. The needs of communities should be studied in order that students in high schools should not be diverted from labor—but rather prepared for it, and for that kind which is locally needed and for which they are individually adapted.

4. High school teachers must study children and their interests, tastes and capabilities more than subjects or syllabuses.

5. Secondary or higher education must not be considered as a means of escape from labor.

6. Many must be prepared to work with their hands.

7. When we have done all this we shall no longer be concerned about the number who leave high school before graduating, and I rather suspect that we shall not long deliberate on whether pupils have read four or six books of Cæsar, nor shall we discriminate against them if, being girls, they have elected cooking instead of physics, or being boys, they have elected modern civics instead of ancient history.

If it be true that the conditions of law and life require or induce the attendance of children in high schools until they are fifteen or sixteen or seventeen, and the conditions of graduation impose a four years' course, it is quite evident that the schools are being maintained, so far as numbers are concerned, for those who do *not* graduate, or who only remain in school one, two or perhaps three years; and this being the case, the principle of "the greatest good for the greatest number" requires that we shall give them particular and special attention.

C. R. MANN,
Secretary

FIFTH MEETING OF THE ENTOMOLOGICAL SOCIETY OF AMERICA

THE fifth meeting of the Entomological Society of America was held at the Harvard Medical School, Boston, December 30 and 31, 1909. The president, Dr. Henry Skinner, presided throughout the sessions. The president announced the deaths of Henry H. Edwards, an honorary fellow, Professor Mark Vernon Slingerland, a fellow, B. H. Guilbeau, W. Brodie and H. M. S. Seib, members. Suitable resolutions on the deaths of Mr. Edwards and Professor Slingerland were adopted. The report of the executive committee showed, among other things, that 16 new members had been received during the year and 22 memberships had terminated, not including those who had died. Also that a memorial drawn up by Mr. N. C. Wood regarding the tariff on insects and signed by the president and secretary had been productive of no action by congress.

The question of appointing delegates to the approaching International Congress of Entomology was referred to the executive committee.

The following officers were elected:

President—Dr. John B. Smith.

First Vice-president—Dr. S. A. Forbes.

Second Vice-president—Professor V. L. Kellogg.

Secretary-Treasurer—Professor C. R. Crosby.

Additional Members of the Executive Committee—Professor J. H. Comstock, Dr. W. M. Wheeler, Mr. E. A. Schwarz, Professor J. M. Aldrich, Rev. Professor C. J. S. Bethune, Professor Lawrence Bruner.

Member of the Committee on Nomenclature—Professor T. D. A. Cockerell (to succeed himself).

The report of the committee on nomenclature concerning the nomenclature of gall insects read at the Baltimore meeting, and printed in the *Annals* for 1909, was adopted as printed, with the provision that the society express itself as standing with the majority of the committee in section V.

Mr. Brues suggested that Professor Felt submit a list of names of gall insects that he thought could be accepted as standard.

Moved and carried that the request of Dr. Stiles published in SCIENCE, for the preparation of a list of one hundred important names to be adopted by the Congress of Zoology as standard, be referred to the executive committee.

The following amendment to the constitution was adopted: Article V., Sec. 3.—Election of officers. All officers shall be elected by ballot at the annual meeting for the term of one year and shall be eligible for reelection. Their term of office shall commence with the first of June following their election.

The secretary was instructed to take a mail vote of all members and fellows of the society as to whether the present arrangement of paying separate dues and subscriptions to the *Annals* should be continued, or a single membership fee of two dollars be charged, and members receive without further expense the publications of the society.

Professor Sanderson suggested the adoption of a uniform style of button for both the entomological societies meeting in affiliation with the Amer-

ican Association for the Advancement of Science. Referred to the officers.

The following papers were read during the sessions:

R. Matheson: "Remarks on the External Anatomy of the Haliplidæ."

W. M. Wheeler: "On the Effects of Parasitic and Other Kinds of Castration in Insects."

Miss A. H. Morgan: "Some Correlations of May-fly Structure and Habit."

C. R. Crosby: "Some Observations by the Late Professor Slingerland and the Speaker on the Life History of *Heterocordylus malinus*" (read by title).

C. J. Triggerson: "The Life-cycle of the Oak Hedge-hog Gall-fly (*Acraspis erinacea*)."

F. L. Washburn: "A Jumping Seed-gall on the Burr Oak."

A. D. MacGillivray: "The Female Reproductive Organs of *Corydalis cornuta*."

W. L. W. Field: "The Offspring of a Captured Female of *Basilarchia proserpina*." To be published in April number of *Psyche*.

H. H. Lyman: "An Improved Drawer for Insect Cabinets and a New Substance for Lining them."

C. T. Brues: "Some Notes on the Geological History of the Parasitic Hymenoptera."

J. C. Bradley: "The Plaiting of the Wings of Hymenoptera."

T. J. Headlee: "An Apparatus for the Determination of Optimums of Temperature and Moisture for Insects."

A. D. MacGillivray: "The Radial Sector in *Phlebatrophia mathesoni*."

W. T. M. Forbes: "A Structural Study of some Caterpillars."

M. J. Elrod: "The Blackfoot Glacier as an Entomological Burying Place" (read by title).

J. J. Davis: "*Chaitophorus populifoliæ* Fitch versus *Chaitophorus populifoliæ* Oestland" (read by title).

L. Haseman: "The Life History of a Species of Psychodidæ" (read by title).

A. G. Hammar: "Notes on the Life History of *Fidiobia flavipes* Ashmead, an Egg Parasite of the Grape Root Worm (*Fidia viticida* Walsh)."

A very interesting and extensive exhibition was held in conjunction with and under the auspices of the Cambridge Entomological Club in rooms adjoining the meeting hall.

The annual public address was given by Dr. John B. Smith on the evening of December 30 in the hall of the Boston Society of Natural History, title, "Insects and Entomologists: Their Relations to the Community at Large."

On Tuesday evening the visiting entomologists were the guests of the Cambridge Entomological Club at a most enjoyable smoker held in Copley Hall.

J. Chester Bradley,
Secretary-Treasurer

THE ASSOCIATION OF OFFICIAL SEED ANALYSTS

The second annual meeting of the Association of Official Seed Analysts was held in Boston, December 28–29, 1909, in connection with the meeting of the American Association for the Advancement of Science.

Agricultural colleges, experiment stations and state departments of agriculture in twelve states and the Canadian and the United States departments of agriculture were represented.

Three papers were presented as follows:

"The Effect of Alternating Temperature, on the Germination of Seeds," by W. L. Goss, U. S. Department of Agriculture.

"Importance of Uniform Methods of Seed Testing," by A. D. Selby, Ohio Agricultural Experiment Station.

"The Sale of Adulterated Farm Seeds in the United States," by E. Brown, U. S. Department of Agriculture.

The greater part of the time of the meeting was devoted to consideration of the reports of the committees on methods of seed testing and on legislation. The report on methods of seed testing for purity was adopted as official by the association and that on germination as provisional. The report on state legislation was adopted and the secretary was instructed to prepare both reports for publication.

E. Brown,
Secretary

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

The 228th meeting of the society was held at the George Washington University on Wednesday evening, February 23, 1910.

Mr. E. W. Shaw, in an informal communication. described a log-shaped mass of sandstone included in coal at Murphysboro, Illinois.

Mr. P. S. Smith spoke on the formation of plain surfaces above base-level, with particular reference to such features observed in Alaska.

Mr. D. B. Sterrett presented a description of peculiar boulder or toadstool-like erosion forms occurring over the outcrop of a batholith of coarse porphyritic granite in York County, S. C. Some of these "toadstools" are ten to fifteen feet high and of similar thickness, and are still firmly attached to the underlying granite mass by stems which may be only one third as thick as the boulder. The granite also outcrops as floors or bosses similar to the occurrences at some of the quarries of the Piedmont region.

Regular Program

Some Mineral Relations from the Laboratory View-point: ARTHUR L. DAY.

The fundamental problems of rock formation, to which petrologists are now giving serious attention, require much more than a perfunctory application of chemistry and physics. The present relations of the minerals in the rocks are accessible to the microscope under convenient conditions of observation, but their development from the fluid magma requires a laboratory study of the rock-forming minerals over a wide range of measured conditions of pressure, temperature and concentration. It is of the first importance that the evidence gathered be quantitative and pertinent to the problem.

Recent laboratory studies have developed the fact that the temperature of crystallization of a mineral from its own liquid or from a mixture is generally variable and therefore untrustworthy in revealing the conditions of equilibrium during formation. Melting point measurements therefore furnish better determinations of the temperature of change of state. It is also necessary that the methods chosen for such determination be appropriate to the substance under investigation, for minerals are characterized by strong individuality of behavior near the melting temperature, which makes it impossible to apply a single property (the appearance of fluidity, for example) to determine when melting occurs in all substances. The lack of sharpness in melting point determinations is partly the result of carelessness in preparation of experimental conditions, partly of molecular inertia or viscosity which prevents any rapid rearrangement of the molecules of the liquid, and occasionally (in isomorphous mixtures) to changing composition during the change of state. The first of these can be eliminated; the second is characteristic of certain minerals and therefore a matter of record; the third is an essential feature of the problem requiring special study. The earlier melting point data offer little evidence upon which to discriminate between these cases. An important factor in rock formation is brought to light by the second of the properties noted above, of which an excellent illustration is found in quartz. In the laboratory, the fusion of pure silica does not occur below 1600° and is accompanied by conditions of extreme viscosity. In nature, vein quartz appears to have crystallized below 800° and to have been very fluid at that temperature. This suggests that volatile ingredients must have assisted in the formation of natural quartz of which only traces now remain, and its proper laboratory study must include these ingredients. The situation also reveals what is perhaps the chief function of pressure in rock formation—namely, in holding the volatile ingredients in solution.

Igneous Metamorphism: A. C. SPENCER.

Platinum in Southeastern Nevada: HOWLAND C. BANCROFT.

At the Key West and Great Eastern prospects in the Copper King Mining District of Clark County, Nev., platinum occurs in peridotite dikes of the enstatite-mica-picrite variety. The properties are situated in the rough foothills of the Virgin Range at an elevation of approximately 3,600 feet and are eight or nine miles from the Virgin River.

The rocks in the immediate vicinity are gneisses, probably of pre-Cambrian age, and are intruded along the planes of schistosity by basic dikes which contain, in addition to platinum, primary pyrrhotite (probably nickeliferous), magnetite, chalcopyrite and pyrite. Besides the peridotite dikes there is also present a typical hornblendite dike which shows upon analysis a trace of platinum. Alteration and concentration of the sulphides in the rock by solutions seems to increase the percentage of platinum and nickel, one analysis showing the presence of .55 of an ounce of platinum to the ton and over 5 per cent. nickel. The dikes as exposed upon the surface vary in width from 10 to 50 feet and are about 100 feet long.

One car-load of ore has been shipped from the Key West workings. If these properties were near a railroad, or if the ore could be treated on the ground, it is quite probable that they would be able to produce bullion. Under present conditions, however, working expenses would be very high.

EDSON S. BASTIN,
Secretary

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

At the regular meeting held at the American Museum on February 14, 1910, Professor C. C. Curtis presiding, the following papers were read:

Variability of Land Snails (Cerion) in the Bahama Islands with its Bearing on the Theory of Geographical Form Chains: Charles B. Davenport.

Professor Plate has described, in the *Archiv f. Rassen- und Gesellschaftsbiol.*, Bd. IV., the different forms of a genus of land snails (*Cerion*) from the Bahama Islands; and declares that the *Cerions* of the north coast of New Providence constitute the best known and most known and most manifold example of such a morphologic-geographic "form chain" as the Sarasins describe. Going from the west to the east end of the island "regular and definitely directed changes" are said to occur "conditioned by the amount of precipitation together with an inner factor—a high responsiveness of the protoplasm."

In January, 1910, I collected shells in New Providence from the localities specified by Plate and from several others. I am now attempting to breed them. Meanwhile the evidence seems opposed to Plate's view, since the "western" type is found at various localities in the east alongside of the eastern type. The facts seem to accord better with the view of the immigration into the eastern end of New Providence of snails having the characteristics of *Cerions* from the Eleuthera Island (an immigration facilitated by geographic conditions) and by the formation of varied combinations of characters and pseudo-blends by hybridization.

Application of the Quadrate-incus Theory to the Conditions in Theridont Reptiles and the Genetic Relations of the Latter to the Mammalia: W. K. Gregory.

Reichert's conclusion that the incus and malleus of mammals represent the vestigial and metamorphosed jaw elements of lower vertebrates, together with the opposing view that these ossicles in the mammalia have been derived directly from the supra- and extra-stapedial cartilages of reptiles, were considered. Exception was taken to Dr. Broom's form of the latter theory, which took the auditory ossicles of the crocodile as a theoretical starting point. All the bones surrounding these elements in the crocodile had evidently undergone certain peculiar specializations and it would be surprising if the auditory ossicles themselves had not also suffered considerable modification in the endeavor to evolve an improved auditory apparatus; the resemblances in the ossicles between crocodile and mammal may therefore be due chiefly to convergent evolution. The modern upholders of the incus-quadrate, malleus-articular theory demand for the ancestral mammal a freely movable quadrate, similar to that of the lizard; but this was because they seem to push too far the biogenetic law. The incus or supposed homologue of the quadrate at present appears in the embryo as a freely movable bone, but this does not prove that it has always been freely movable. These investigators had passed by the theridonts of the Permian and Triassic because in these reptiles the quadrate was fixed at its upper end; but a slight atrophy of the posterior border of the squamosal would have greatly increased the mobility of the quadrate.

Paleontological and embryological evidence showed that the existing joint between the skull and the lower jaws in mammals is a neomorph, probably developed *pari passu* with the atrophy of the quadrate and articular bones. The application of Reichert's theory to the Theriodontia required only that the vestigial quadrate should be freed from its squamosal socket, and secondly that it and the articular should be brought into contact with the stapes or primary auditory rod. But how can we conceive an adaptive, mechanical motive for this extraordinary change? Such seems to be furnished by the embryology of the tympanic chamber of mammals. As is well known, this chamber appears below the ossicles as a diverticulum of the first gill opening. It grows upward and embraces the ossicles, which finally appear to be inside the cavity but are morphologically outside of it, since they never pierce its epithelium. So in the hypothetical pro-mammal the vestigial quadrate and articular on the one hand and the stapedial rod on the other may have been embraced by the up-growing tympanic sack or chamber and finally pressed into contact with each other. The vestigial jaw elements may thus have come to share in the vibrations of the chamber and of the stapes, and thus was initiated their career as accessory auditory ossicles. A somewhat analogous case is the transformation in siluroid fishes of certain vertebral appendages into a chain of ossicles for transmitting vibrations from the air bladder to the internal ear.

L. Hussakof

SCIENCE

FRIDAY, APRIL 22, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE CHOICE OF MEDICINE AS A PROFESSION[1]

ONE of the most difficult and important questions for the college student to decide is the question: "What occupation shall I choose when I graduate from college?" It is a question, moreover, which every student ought to decide for himself. Every person's occupation should be suited to his tastes and capabilities and no one can decide whether a given occupation is suited to an individual's tastes and capacities so well as the individual himself. It makes no difference who the student is or what he is; if he is the millionaire's son and foolishly believes he need pursue no occupation at all, or if he is the merchant's son and is destined to fall into some niche prepared for him by parental industry, the truth still remains that if he is to enjoy the best gifts of life he must have occupation and that the occupation chosen should be one in which he can labor happily and usefully. Every student here present should study this question with the conviction that it is in many respects the most important and vital question of his life.

You are all to be congratulated upon the opportunity which is offered you for securing a college education. Whatever you eventually do, whatever occupation you elect to pursue, this college education will stand you in good stead, the higher its value the more wisely you avail yourselves of the opportunity it offers. It is somewhat the fashion nowadays to carp at the so-called liberal education and it is cer-

[1] Lecture delivered November 2, 1909, to the students of Tufts College.

tainly true that it does not accomplish all we have expected of it, a question we can not consider at the present time. Many persons have attempted to say what this same liberal education ought to consist of. In my opinion we may seek far and yet find no better definition than that given by Huxley. He said:

> That man, I think, has had a liberal education who has been so trained in youth that his body is the ready servant of his will, and does with ease and pleasure all the work that, as a mechanism, it is capable of; whose intellect is a cold clear logic engine, with all its parts of equal strength and in smooth working order; ready like a steam engine, to be turned to any kind of work, and spin the gossamers as well as forge the anchors of the mind; whose mind is stored with a knowledge of the great and fundamental truths of nature and the laws of her operations; one who, no stunted ascetic, is full of life and fire, but whose passions are trained to come to heel by a vigorous will, the servant of a tender conscience; who has learned to love all beauty, whether of nature or of art, to hate all vileness, and to respect others as himself.

Such an education as this Tufts College will give you if you do your part; such an education as this will prepare you for any vocation and, better still, will furnish you with the general knowledge which will enable you to select your eventual occupation understandingly. But remember too, as Gibbons says, that: "Every one has two educations, one which he receives from others and one, more important, which he gives himself." Do not neglect this self-education.

The earlier in your college course you are enabled to choose your profession, the better it will be for you, because early decision will enable you to choose your elective studies in such a manner as to bear directly upon your professional work. Mr. Flexner in an article in SCIENCE has said that "statistics roughly compiled seem to indicate that perhaps seventy-five per cent. of the members of the first-year law classes at Columbia and Harvard knew while in college that they would study law afterwards," and this would certainly indicate that an earnest student should be able to make his decision early enough to take advantage of the college offerings. Unfortunately it is the case that many college men form false ideals of what the professions really are. They idealize them from too narrow a view point, and slowly learning that they are different in a practical way from the conceptions they have formed, they become dissatisfied with them. They become, as it were, the round pegs in the square holes. They do not fit. They have chosen professions for which they are unsuited. This idealization of the profession is especially true of those contemplating the study of medicine. If we could look into the different aspirants' minds and see depicted there the different ideals that each one had formed, I am sure we should find a strange and incongruous society of physicians!

But, on the other hand, we should find that all had idealized certain qualities, though in different proportions. One man sees himself as the noted surgeon dashing about the country in his high-power motor, performing miraculous operations with curiously shaped instruments, and reaping a huge harvest of professional fees. Another sees himself the fashionable consultant, the Doctor Firmin, concerning whom Thackeray has told us so much, without whose approval and advice no one who is any one (at least so far as his bank account is concerned), can pass conventionally to the grave. Another pictures himself as the man of science working in his laboratory and discovering the cure of cancer, which shall make him for all time a benefactor of the human race; or he sees himself the special-

ist who knows everything which is known in some small branch of medical knowledge, and who is bending his best endeavors to searching out those secrets of his specialty which are as yet unknown. Or he sees himself as the teacher who is helping others to prepare themselves for the medical profession; or as the army surgeon whose medical knowledge is making possible some vast engineering achievement like the Panama Canal; or the surgeon on the side lines who dashes out to render first aid to the injured gladiator of the football arena, or as the medical expert, clashing swords with the cross-examining attorney in the heated atmosphere of the brain-storm. Or lastly he sees himself as the old-fashioned country doctor, passing his life among the tranquil beauties of nature, and driving in his battered buggy from village to village and from farmhouse to farmhouse, succoring the wounded, tending the sick; alleviating their pain and directing their treatment, a veritable good samaritan doing his best for the good of his fellows; making a sufficient livelihood for his simple wants and happy in the position he has made for himself, a respected councillor and loved friend.

Such are the various aspects in which the physician ordinarily appears to the average lay mind; as the surgeon, the consultant, the specialist, the expert, the official, the teacher, the hygienist and the general practitioner or family physician—or as one combining any or all these functions in varying degree. And such to a certain extent the average physician really is and the diversity of his functions is one of the great attractions of the profession. Ideals of such types blended together represent what the medical profession really is, but by far the preponderating type is the type of the old-fashioned country doctor, the general practitioner whether he be in country or in town.

By far the larger part of the regular medical profession of to-day is the family physician, who pursues medicine for the love he has for it and for the love he bears his fellows. And I say this confidently, knowing them as I do, and speaking concerning them and not as one of them. But I believe it would be hard to make them confess it of themselves, for the twentieth-century physician does not wear his heart upon his sleeve. He is half ashamed of his altruistic tendencies and often tries to hide them under a cloak of simulated roughness. He labors without pay in the hospitals and the slums; he forgets the weariness of his body and the pleasure of its indulgence in his delight in his calling; he is charitable to the poor; considerate of the moderately-well-to-do; he is a friend to those in affliction and is always ready to assume their burdens. If his work is arduous and the rewards are small, if his patients are exacting and his worries are great, he is always buoyed up by the consolation of the scientific interest of his work and by the knowledge of its usefulness. He is to-day a worthy exponent of the highest and noblest of all the professions, "the flower of our civilization," as Robert Louis Stevenson has said, and his duties are often of such a nature as to enable him to touch the heroic.

An incident of this latter nature, relatively so common in medical practise as scarcely to excite comment among physicians, was related to me the other day by a spectator, because of its humorous aspect. The patient, a child, was dying of blood poisoning and it was hoped that by the transfusion of blood from a healthy living person by the new Crile method, its life might be saved. Several members of our pathological department offered their

blood for this purpose and one of them was chosen. Let me remark, in passing, that he had never before seen the child nor its parents. An incision two or three inches long was made in his arm, deep enough to expose his radial artery. The artery was drawn from its sheath, cut squarely across, a tube was inserted in its lumen and the blood from his body permitted to flow into a vein of the unconscious child, the arms of the donor and the recipient being bound closely together. This juxtaposition was continued for twenty minutes or more. The pain to the donor was sickening, a pulsating drag on the incised artery and its moving contact against the sensitive cut skin; the danger was frightful, for let but one of those minute organisms causing the blood poisoning in the child enter into the circulation of the volunteer and his fate was sealed. Anxiously the group of physicians at the bedside watched the increasing pallor of the donor, and the tension became so great that they could hardly bear it. Then one of them (himself a volunteer) remarked: "How does it feel, Larry, to be a martyr?" and in the smile which followed, the situation was saved. And the story was related because of its humor!

To attain success in the practise of medicine a man must possess knowledge to decide and courage to perform combined with a love for truth, honor, justice and purity. Such success means for the most part moderate competency, a large part of the compensation being its scientific interest and the satisfaction experienced by the knowledge of a duty well performed; any one who has experienced the satisfaction of alleviating pain or saving life will not underrate this compensation. It can not be estimated in money terms, but even in this mercantile age the average physician is one who feels more satisfaction in the thought that he has saved the life of a child for its parents, or that of a mother for her children, than would come to him in the enjoyment of the steam yacht of modern high finance. As a money-making profession medicine ranks low. The same capital, industry and time would bring a larger financial return in almost any other calling. At present it may be said of the profession that most of its votaries make a modest income and but few a large income, though it can not be denied that there are a few who enjoy very large incomes derived from the profession of medicine. Any one who estimates the values which money can buy as above those which I have tried to indicate would do well to choose some other profession.

But there are also other advantages in the profession of medicine as a life work.

In the first place it is essentially a gentleman's profession. No one can succeed in it unless he be a gentleman at heart, and this fact, well understood, admits him into the best and pleasantest circles of the social community. He meets people of culture; he associates with educated men and women; with those who make and administer our laws and who direct our charities and educational institutions. Such environment is enormously stimulating to his intellectual life.

In spite of the fact that he is anybody's servant, he is nevertheless his own master. He can arrange his work to suit himself and he submits to no dictation as to how it shall be done. It is he who decides what he shall do and how he shall do it. He is not, as in so many other occupations, the instrument of another's will.

Notwithstanding the fact of the arduousness of his calling, he has, of course, his periods of leisure, and this leisure is at his own disposal, as is the case in few other occupations. His home life is perhaps more complete than is found in any other

occupation excepting the ministry. His reading is broad, and always dealing with new things, and in this way his interests are continually broadening.

Another advantage of his profession is his association with all classes of the community, with men, women and children, whereas in other callings his association is chiefly with men. In other words, he is studying humanity instead of pursuing the elusive dollar.

Mr. Barney, last week, spoke to you of the crowded condition of the profession of the law. The profession of medicine is also crowded. But reviewing the question judicially, so, it seems to me, are all the other professions and callings, this crowding and competition extending into every branch of human activity wherein men and women gain a livelihood. At the present time the only exception to this rule seems to be the general-housework girl!

Speaking of the profession of the law, it is customary to point out to aspirants for legal honors the value of a knowledge of law in other departments of human activity, and students are told of the immense collateral value of such a knowledge in politics; in administrative positions; in banking, real estate, insurance and other occupations; and the implication is made that medicine relates only to the simple practise of medicine. Such a conclusion as this is a greatly mistaken one. Medicine in recent years has experienced such a broadening of its field of usefulness as is the case in no other profession. The foundation of such institutions, the Rockefeller Institute, etc., has created an entirely new field for the physician in the direction of the research worker. Nearly every hospital of note throughout the country has established such laboratories for the study of the causes and prevention of disease, and it is a matter now beginning to be well understood that the duty of the hospital is not only to care for the sick, but to study new methods for the cure and prevention of disease among the well. Such positions as these call for highly trained medical men, and it is a field which will soon be greatly enlarged by the establishment of clinical chemical laboratories as well as those for pathological and bacteriological research.

The great expansion of our life insurance companies has necessitated the employment of a greatly increased number of physicians, and the time is not remote when these great institutions will understand the benefit which will accrue to them in the establishment of research workers who shall demonstrate lines upon which human life may be prolonged.

The increase in the size and number of charitable institutions also calls for a largely increased number of medical attendants and new necessities caused by our extending civilization are daily springing up—such necessities as the supervision of our water supplies; our drainage disposal; physical culture; quarantine regulations and board of health investigations. In fact all the great economic problems of the day are problems which must be largely decided by physicians; as examples of which attention is directed to the supremacy of the Japanese in their struggle against Russia, a supremacy largely due to the health and effectiveness of their troops, as perfected by physicians. And the German exploitation of Africa and the building of our own Panama Canal, were both rendered possible by the conquest of the tropics by the physician.

And we see the trained physician sought out as a teacher of sociology, of psychology, of zoology and physiology and in other fields as yet barely touched by the plough of progress. Such teaching posi-

tions can generally be associated with a position in a hospital or public institution also carrying a small salary, and afford a highly attractive means of gaining a modest livelihood.

The preparation for the practise of medicine calls for four years of hard but interesting work in the medical school, and at least one year's supplementary work in a hospital. The medical school work is elaborately described in all medical school catalogues. To describe it here would be beyond the scope of the present lecture. It might be briefly summed up as a study of the human body in health and disease, and the study of disease with its causes, prevention and treatment. The hospital work means the actual practise of medicine in the hospital under the direction of an experienced physician.

Now the preparation for the medical-school work in the college should in my mind be somewhat along the following lines:

In the first place I would advise every student to do some work every day. The enthusiastic student could do more, and the less enthusiastic less, but I would advise every student to do some, and it is astonishing how much one can accomplish by steady persistent routine work, even if but little time is devoted to it. And I would also advise every student to study some subject thoroughly, the idea being that he should understand what it involves to acquire accurate, precise knowledge; partly that he should have the benefit of the mental training thereof, and partly that he should have the direct benefit of the knowledge itself.

Lord Broughton's ideal of education was to know something of everything and everything of something. Of course that is not practical now-a-days when knowledge is so diverse and extensive, but to know a few subjects pretty well and one subject very well seems to me to be all we have a right to expect from the average college student. To express this in different terms; I mean that it is fair to at least ask of a conscientious student that he should each year receive a good passing mark in all his studies and an A or B in one. Another thing which he should get from this college training is a good physique, for the mere physical work of the study and practise of medicine is such as to demand a strong and vigorous body. Epictetus said that he was a spirit dragging about a corpse! Let no such spirit as this contemplate the study of medicine! And he should have a well-disciplined mind, because the study and practise of medicine call for a high degree of self-control.

Special studies given in the college which will be of inestimable value to him in the medical school are biology (including botany), physics, chemistry, Latin and Greek, English, German and French.

I have placed biology first because I consider it of the first importance, and let me say, in passing, that you, as students of Tufts College, are fortunate in having at the head of your department of biology one of the most distinguished biologists in the country. It is a great privilege to be allowed to sit under this inspiring teacher and at the risk of making myself unpopular with him, I would advise every student in the college, no matter what he intends to be, to take at least one course in biology, that he may learn what science and scientific methods really mean. By studying biology you not only are enabled to form a pretty correct idea as to what the study of medicine is like; to judge whether or no you are likely to make a success of it; you not only familiarize yourselves with the scientific methods of study, cultivating

your powers of observation, of noticing similarities and differences, and of describing what you see, learning to use the scalpel and the microscope; but you also store your mind with a knowledge of facts, processes and methods which will later be of direct value to you in the study of medicine. It would be hard for you to realize how much time is lost in teaching medical students these methods of study which each one of you should acquire without unusual effort in your college course. It is sometimes said of the work in college that it is not so much the things you learn as the knowledge of how to learn which is valuable to the student in after life. I think this statement conveys a false impression. It seems to me that the college student preparing himself for the study of medicine can not only learn how to study to the greatest advantage, but that he can also store his mind with facts and principles which will be of enormous value to him. I believe that the mind should be regarded in part as a storehouse of facts, which can be drawn upon in emergency like a balance in the bank. I have never heard any one question the utility of a bank balance unless perchance it was too large! Another advantage to the medical student of the study of biology in college is that it familiarizes him with animal life in its simplest forms before he begins to study it in its most complex form as evinced in man. By such study he is enabled to take a bird's eye view, as it were, of his subject before he devotes himself to its intimate study. It is like studying the map of a city before we explore the city.

Second to the study of biology, in its importance to the medical student, I should rank physics. No one can properly understand the various processes of the human body who does not possess a knowledge of physics. Everything we do, everything we say, everything we think and everything that goes on within us is due to physical cause, and a knowledge of these underlying physical principles is absolutely essential to a knowledge of medicine. I rank physics second to biology only because some knowledge of physics must of necessity be included in a knowledge of biology.

Third on my list of collateral studies comes chemistry. A knowledge of chemistry is of absolute necessity to the medical student because it deals with the composition of everything he comes in contact with. Before he can study material things to advantage he must know of what they are composed. So important is chemistry that it is taught in the different degrees in every medical school in the country, but it would be of the greatest advantage to the prospective medical student if he could obtain a good general knowledge of organic and inorganic chemistry, including qualitative and quantitative analysis, before he entered the medical school; it would give him extra time for his purely medical studies, and it would enable him to master more easily his biological and medical chemistry. Chemistry, as you know, has a language of its own and a great saving of time is made if the language alone is acquired.

Fourth in importance in the list of collateral studies is Latin, important to medical men because it is the language of the scholar and because medical men should be preeminently scholars. The language of medicine is essentially derived from the classics; every bone and every muscle, every artery and every vein; every nerve and every organ is described in terms of classical derivation. So also are all the drugs, and even our prescriptions are written in Latin, though the Latin in some instances would give Cicero a surprise he

would never recover from! Some knowledge of Latin is essential; a more extended knowledge is highly desirable as an accessory aid to memory.

Advanced English I place fifth in my list, giving it a lower place because a knowledge of English is presupposed. But in including it I mean to advise the more advanced and critical knowledge of the language; a knowledge which permits us to speak and write it fluently and elegantly. A knowledge which has enlarged our vocabulary and has made us widely acquainted with English literature and its development—a knowledge which has developed the reading habit and which makes us familiar with other people's thoughts and habits of thought. If I were to teach English to prospective medical students, I should also lay great stress upon the daily theme upon current events.

German and French I place sixth and seventh in my list as valuable chiefly by enabling us to become conversant with the literature and scientific progress of other nations and peoples. One or more foreign medical journals a week help one amazingly to keep pace with foreign progress. German and French are valuable, too, as enabling us to communicate at first hand with foreigners if we study abroad, or with our foreign patients in practise at home. Few persons, not physicians, realize how greatly our foreign population is increasing. I remember at my clinic one day, when I was late, and four children had been kept for me to examine, that one was an Italian, one a Russian, one a Greek and one a Syrian!

Economics and sociology would come eighth and ninth in the procession, both of immense importance to the medical man; tenth and eleventh, at the risk of being called an iconoclast, I should rank drawing and painting, and shorthand writing, and to round out the dozen, let us add public speaking.

These subjects will not, of course, occupy the student's whole time while in college. Place is left for other elective studies. In these other elective fields the student can roam according to his fancy. The suggested studies form the basis of his work; the supplementary excursions furnish variety. Nothing is lost from the broadening effects of his college course, but much is gained from its concentration.

And now, before I release you for your short respite of well-earned leisure, let me quote to you the words of Kipling to the students in a London Hospital, and say that I need not "stretch your patience by talking to you about the high ideals and lofty ethics of a profession which exacts from its followers the largest responsibility and the highest death rate—for its practitioners—of any profession in the world. If you will let me, I will wish you in your future what all men desire—enough work to do and strength enough to do the work."

HAROLD WILLIAMS

TUFTS COLLEGE MEDICAL SCHOOL

AN INTERNATIONAL COOPERATIVE INVESTIGATION ON ELECTRICAL STANDARDS

THE International Electrical Conference, which met in London in October, 1908, passed certain resolutions with regard to electrical units and standards, but left to an international committee, which was established at that time, the duty of completing the specifications for the concrete electrical standards, and of deciding upon a new numerical value for the Weston normal cell which could be adopted internationally.

As is well known, the value for the Clark standard cell (1.434 volts at 15° C.) which was adopted by the Chicago Electrical Congress in 1893, was not accepted by Germany. After further experimental investigations, Germany adopted the value, 1.4328 volts at 15° C. England, America, France and some

other countries have followed the Chicago Congress, whereas other countries have followed Germany, and hence there have been two different values for the volt in use.

In course of time, the method of preparation of the Clark cell was improved so that the cell became more reliable, but at the same time its electromotive force was slightly altered. At the Bureau of Standards, an allowance was made for the change in the E.M.F. of the Clark cell, so as to preserve the unit of electromotive force unaltered. In England, however, the original numerical value was retained in spite of the fact that the new cells had slightly different values from the old. The result was that a discrepancy arose between the values in use in England and America. Hence, there were and still are three different volts in use in different countries. The Weston normal cell, officially adopted at the London Conference in place of the Clark cell, has the following values: In America, 1.0189 at 25°, equivalent to 1.019125 volts at 20°; in Germany, 1.0186 volts at 20°; in England, 1.0184 volts at 20°. Some of the other countries have the same value as America, others the same as Germany. England adopted the last-named value only one year ago, and no other country, as far as known, has followed its example.

The London Conference of 1908 adopted the ohm as represented by the resistance of a specified column of mercury, and the ampere as represented by a certain mass of silver deposited in a silver voltameter, as the two independent fundamental electrical units, and declared that the value of the volt should be derived from these two. The electrochemical equivalent of silver adopted at London was 1.11800 milligrams of silver per second per ampere of current. It was known that different investigators had obtained different values for the electrochemical equivalent of silver, according to the kind of voltameter used and the methods of preparing the silver nitrate, so that the international committee found itself confronted with the problem of preparing specifications for the voltameter, when there was a great difference of opinion as to the proper procedure and as to the true value of the electrochemical equivalent of silver, which had, however, been definitely fixed by the conference.

The International Committee on Electrical Units and Standards is authorized by the London Conference to complete the work of the conference and to carry on intercomparisons of standards among different countries, and to promote investigations upon the subject of electrical units and standards, to the end of securing international uniformity with the highest obtainable accuracy. This committee represents eleven different countries, there being two members each from America, England, France and Germany, and one member each from Austria, Italy, Russia, Switzerland, Holland, Belgium and Japan. The president of the committee is Professor Dr. E. Warburg, president of the Reichsanstalt, Berlin; vice-president, Dr. R. T. Glazebrook, director of the National Physical Laboratory, London; treasurer, Professor S. W. Stratton, director of the Bureau of Standards; secretary, Professor E. B. Rosa, physicist of the Bureau of Standards. The other eleven members of the committee are as follows: Dr. Osuke Asano, Department of Communications, Tokyo, Japan; M. René Benoît, Bureau International, Sevres, France; Dr. N. Egeroff, director, General Chamber of Weights and Measures, St. Petersburg, Russia; Professor Eric Gérard, Liège, Belgium; Professor H. Haga, Groningen, Holland; Dr. Ludwig Kusminsky, Commission of Weights and Measures, Vienna, Austria; Dr. Stephen Lindeck, Physikalisch-Technische Reichsanstalt, Berlin, Germany; Professor Gabriel Lippmann, The Sorbonne, Paris; Professor Antonio Ròiti, Florence, Italy; Mr. A. P. Trotter, Electrical Standards Laboratory, Whitehall, London; Professor H. F. Weber, Zürich, Switzerland.

In addition to the fifteen members appointed by the International Electrical Conference, the committee was authorized to elect associate members to assist in carrying on its work, and at its first meeting in London, following the conference, five associate members were elected as follows: Dr. W. Jaeger, of Berlin; Mr. F. E. Smith, of Lon-

don; Professor Paul Janet, of Paris; Professor H. S. Carhart, of Ann Arbor, Michigan, and Dr. F. A. Wolff, of the Bureau of Standards, Washington.

It was impossible to select a new value of the Weston normal cell in terms of the ohm and the ampere until the latter should be more precisely defined than had been done by the London Conference. Correspondence among the members of the committee who were connected with national standardizing institutions seemed to indicate that it would be impossible to agree upon the specifications of the silver voltameter without further investigation, and it was proposed by the American members of the committee that a joint investigation to clear up, as far as possible, outstanding problems on the standard cell and the silver voltameter be arranged with representatives of several of the national standardizing laboratories as participants. Professor S. W. Stratton in his capacity as director of the Bureau of Standards offered the facilities of the Bureau of Standards for an international investigation, and in his capacity as treasurer of the International Committee on Electrical Units and Standards offered to secure the funds to pay the expenses of the investigation. In this connection he received valuable assistance from Mr. John W. Lieb, Jr., who placed the matter before the governing bodies of the American Institute of Electrical Engineers, the National Electric Light Association, the Association of Edison Illuminating Companies and the Illuminating Engineering Society. These four societies made appropriations of $500 each to defray the expenses of the proposed investigation. Their generosity in this matter is very highly appreciated by the International Committee on Electrical Units and Standards. Some smaller contributions were also received.

It was arranged that the proposed investigation should be carried out at the Bureau of Standards by representatives of that institution together with one delegate from the Physikalisch-Technische Reichsanstalt, Berlin, one from the National Physical Laboratory, London, and one from the Laboratoire Central d'Electricité, Paris. The European delegates, as appointed by the directors of the three above named institutions, are Professor W. Jaeger, Mr. F. E. Smith and Professor F. Laporte. These gentlemen have had a very considerable experience in work with standard cells and silver voltameters, have published various investigations on the same, and are eminently qualified to represent their respective institutions and to join in the work of research and deliberation upon the various questions that will arise during their stay in Washington. The representatives of the Bureau of Standards are Professor E. B. Rosa and Dr. F. A. Wolff. In addition to published papers, a great deal of experimental work has been done at the Bureau of Standards which is not yet published, which throws considerable light upon the questions at issue.

In addition to the work on standard cells and the silver voltameter, a comparison is to be made of the resistance standards of the several national standardizing institutions. The wire standards of the Reichsanstalt, the National Physical Laboratory and the Bureau of Standards differed only about two parts in a hundred thousand at the last intercomparison about a year ago, the standards of the first two of the above institutions having been fixed independently by legally specified mercury ohms. It is expected that a common value of the international ohm will be agreed upon, so that no difference greater than one part in a hundred thousand will exist between the wire standards of the national standardizing institutions.

It is confidently expected that the committee will succeed in coming to a satisfactory agreement with respect to the official specifications of the silver voltameter and the Weston normal cell, and will be able to agree upon a value for the latter which can be recommended to all countries of the world for adoption. The degree of accuracy which is now obtainable in electrical measurements, both in absolute measurements and in relative measurements, far surpasses what was possible in 1893, and indeed has increased greatly within the last five years. There is

reason to believe that values adopted now will be satisfactory for a generation at least without change. The European delegates have brought with them, from their own laboratories, a quantity of apparatus and chemicals in order that they may reproduce work done in their own laboratories at the Bureau of Standards, as accurately as possible. Standard cells will be set up by the representatives of each of the four institutions, and accurately compared and tested. In the same way different forms of silver voltameters will be operated in series with one another, and the quantity of silver deposited in each determined with very great accuracy. The Bureau of Standards has provided every facility for carrying on this work expeditiously and with the highest precision.

The three European delegates arrived from Europe recently, and proceeded to Washington after a short stay in New York, in time to begin their work at the appointed time, April 1. It is not known how long the work will continue, but it is hoped to complete it in two months.

Edward B. Rosa

FEDERAL EXPENDITURES FOR THE CONSERVATION OF THE NATIONAL HEALTH

Certain contributors to *American Health* (the official organ of the American Health League, published by the Committee of One Hundred) have expressed the opinion, that while the care and health of animals is a matter of extreme importance to the federal government, the health of human beings, on the other hand, is a matter of indifference. At least, this is what one would infer from the following quotations taken from *American Health:*

John Pease Norton, Ph.D., *American Health*, March, 1908, page 12:

We look with horror on the black plague of the middle ages. The black waste was but a passing cloud compared with the white waste visitation. Of the people living to-day over eight millions will die of tuberculosis, and the federal government does not raise a hand to help them.

THE DEPARTMENT OF AGRICULTURE PROTECTS ANIMALS

The Department of Agriculture spends seven million dollars on plant health and animal health every year, but, with the exception of the splendid work done by Doctors Wiley, Atwater and Benedict, Congress does not directly appropriate one cent for promoting the physical well-being of babies. Thousands have been expended in stamping out cholera among swine, but not one dollar was ever voted for eradicating pneumonia among human beings.

Mrs. Gibson Arnoldi, Bulletin of the Committee of One Hundred on National Health, September, 1909, page 8:

The national government of the United States spends $7,000,000 on plant and animal health every year, and hundreds of thousands fighting beetles and potato bugs, but not one cent to aid the six million babies that will die under two years of age during the next census period while mothers sit by and watch in utter helplessness. This number could probably be decreased by as much as one half. Why is nothing done? . . .

Bulletin No. 33 of the Committee of One Hundred on National Health, October 1909:

At a meeting held in Denver in August an interesting paper on meat inspection was read by Miss Lakey, chairman of the food committee of the National Consumers' League. Resolutions were adopted recommending that states and cities should provide more sanitary slaughter houses. Miss Lakey showed that the federal inspection is inadequate.

To those who are more familiar with the health work now being carried on by the federal government here at Washington and in its branch laboratories, these statements, while correct as to certain details, are objectionable because of their implications. The above quotation from Bulletin 33, for example, was so placed as to carry (to the writer at least) the impression that the federal inspection was being criticized, not alone as to the quantity of meat inspected, but also as to the quality of the inspection. The writer has been corrected by one who attended the Denver meeting of the Association of State and National Food and Dairy Departments, and informed that the federal meat inspection service was held up by Miss Lakey as a good

example to be aggressively followed by state and municipal health boards. Inefficiency was not implied.

The object of this article is not to criticize these contributors or the Committee of One Hundred, but rather to point out that, far from being a matter of indifference, the national health is a matter of the gravest concern.

For what purpose is the health work now being carried on in the following federal departments?

First: The Bureau of Chemistry. The work of this bureau (involving an annual expenditure of approximately $750,000), particularly in the enforcement of the food and drugs act, is too well known to need description here. Even the babies have not been forgotten; the composition and digestibility of baby foods have been studied; a more detailed and thorough study of the subject has been planned and will probably be in progress in the near future. Considerable work is being done upon "soothing syrups" manufactured and sold in violation of the food and drugs act.

Second: The Hygienic Laboratory of the Public Health and Marine Hospital Service. This laboratory has made investigations along several lines. Certain parasitic diseases in *man* (*e. g.*, hook-worm disease) have been studied; milk and its relation to the public health has been a subject of both extensive and intensive research. Investigations of the dissemination of tuberculosis and typhoid fever through interstate traffic are in progress. The Marine Hospital Service maintains the federal quarantine (appropriation—$400,000 for the fiscal year ending June 30, 1909). For the same year congress appropriated $700,000 to be used by the Public Health and Marine Hospital Service "in case of threatened or actual epidemic of cholera, typhus fever . . . in aid of state and local boards . . . in preventing and suppressing the spread of same. . ."

Third: The investigations on the food and nutrition of man now being carried on through the Office of Experiment Stations. Likewise, of undoubted value is the work of the Surgeon General of the United States Army. The work done by that office in pointing out the relation between the mosquito and the spread of yellow fever is obviously of vital importance.

Fourth: The Bureau of Animal Industry. In this bureau the federal health work is being carried on through several of its divisions. The Meat Inspection Division (for which congress appropriates $3,000,000 per year) inspects the inter-state traffic in meat, thus assuring the country a clean meat supply. Hook worm in man was first suspected through the work that has been done with this parasite in animals.

To certain criticisms of the federal inspection a very interesting reply by the Bureau of Animal Industry is to be found in the Twenty-third Annual Report of that bureau for 1906, page 443, *et seq.*

The Dairy Division is making every effort to cleanse and purify and improve the milk and dairy products of the country. The proper construction, care and ventilation of the barn, as well as improved methods of making cheese, are subjects of investigation. For the inspection of butter-renovating factories $10,000 are expended annually. For investigations on methods of improving the quality and quantity of dairy products, $30,000 are expended annually.

If the amount of money expended by the federal government through these several bureaus (considerably over $4,000,000 per annum) may be taken as a correct measure of the interest taken in their work, it follows that the national health is a matter of something more than incidental interest to the federal authorities. The above-mentioned amounts, however, do not by any means represent the total amount expended through channels making for the national health. If the eating of certain abnormal varieties of corn in certain localities induces seriously diseased conditions in the people eating it, is the expenditure in studying the biology of the corn any less useful than that in studying the disease in man?

The relations of some of the branches of federal activity to the public health are very direct and obvious. Some of the investigations of the Hygienic Laboratory of the Public Health and Marine Hospital Service, for example, resulting in the tracing of typhoid fever to contaminated milk, are evidently made for the immediate protection of the public. The work of the Meat Inspection Division in preventing the sale of the meat of diseased animals is just as immediate in its purpose. It is evident that a plentiful supply of wholesome food is as essential to the health of a people as any other measure for the prevention or eradication of disease. Well-nourished bodies may resist disease where impoverished ones succumb.

But the bearings of other branches of federal activity upon the public health may not be so obvious to the superficial or casual observer. To such an observer the study of the proper construction and ventilation of a barn may not be as close to the public health as the study of the properties of an antitoxic serum. But in these days of preventive medicine we are willing not alone to be cured of disease, but even to prevent it in almost any way whatsoever—for example, by using only clean milk, from clean, healthy cows, and which obviously can only be kept clean and healthy in barns of sanitary construction and ventilation. The enemy (the pathogenic microorganism in this case) will enter through any gate. All of them must be closed.

The figures quoted above have been taken from Document No. 1,031, House of Representatives (Treasury Department Document No. 2,516), Estimates of Appropriations for the fiscal year ending June 30, 1910; also, Treasury Department Document No. 2,533, Statements of Balances, Appropriations and Disbursements of the Government for the fiscal year ended June 30, 1908. Both of these publications are easily obtainable by those interested, at the Library of the U. S. Department of Agriculture.

W. N. BERG

WASHINGTON, D. C.

A DEPARTMENT OF PUBLIC HEALTH

SENATOR OWEN has introduced in the senate a bill establishing a Department of Public Health, which has been read twice and referred to the Committee on Public Health and National Quarantine. The principle of this bill has been approved by the committee of one hundred of the American Association for the Advancement of Science, and members of the Association are urged to make efforts to secure the passage of the bill, more especially by writing letters to members of congress endorsing the *principle* of the bill and in favor of a wide extension of the present health work of the national government.

President Taft, in his public addresses, as in his first annual message to congress, both the great political parties in their platforms, the National Grange, the American Federation of Labor, the American Medical Association, the Committee of One Hundred, and others, have put themselves on record as in favor of a broad reform of the existing situation. It is important to impress upon congress that there is a thoughtful and widespread demand in this country for comprehensive reform at this time.

THE AMERICAN CHEMICAL SOCIETY

THE summer meeting of the American Chemical Society, to be held in San Francisco, July 12–15, 1910, promises to be one of the pleasantest outings ever enjoyed by the members of the society.

A special train made up of the Santa Fe's finest equipment will leave Chicago on the evening of July 4, arriving at Colorado Springs on the morning of July 6. About six hours will be allowed for a trip to Manitou, the Garden of the Gods or to the top of Pikes Peak. Leaving about one o'clock the train will reach Adamana on July 7 and a half day will be spent in a visit to the Petrified Forests, two of which and possibly three may be examined. Leaving Adamana that night the party will arrive at the Grand Canyon of the Colorado on the morning of July 8 where the day will be spent. Leaving the Grand Canyon that evening the train will arrive at Redlands

and Riverside, California, the following afternoon and about two hours and a half will be given to the semi-tropical scenery of each of these two cities. Sunday, July 10, will be spent at Los Angeles, leaving there in the evening and arriving at Lang, Cal., on the following morning. At Lang the borax mines will be visited on invitation of Mr. S. T. Mather, of the Thorkildsen-Mather Company, where the party will be their guests until about 1:30 o'clock, when the train will leave for Santa Barbara, giving us about five hours in that unequalled seaside resort. During the night the train will leave for San Francisco via the coast route of the Southern Pacific, probably reaching our destination about twelve o'clock on July 12.

The meeting will follow and our entertainment by the California Section. The tentative program for our entertainment includes: first, a steamer trip around the Bay and out through the Golden Gate; second, a trip to the top of Mt. Tamalpais and to the Muir Woods, the first giving us an extensive view of the ocean, the bay and the surrounding mountains and hills, while the second contains fine specimens of the coast redwood (*Sequoia sempervirens*); third, an excursion on the Ocean Shore Railway to Pescadero with a possible return via the Santa Clara Valley; fourth, an excursion to the vineyards and wineries of the Italian-Swiss colonies in Sonoma County; fifth, a visit to the University of California at Berkeley; sixth, a visit to Stanford University with a possible automobile trip through the orchards of the Santa Clara Valley; seventh, a camping out trip for one night and parts of two days into the Big Basin, the State Park, where some of the biggest redwoods are to be seen; also it is hoped to visit some of the local manufacturing plants.

Following the meeting the party will dissolve as a whole, returning as they desire, either via the smelters in Utah and Colorado, via the beautiful scenery of the Canadian Pacific, or via the National Yellowstone Park.

Unusually low rates have been obtained from Chicago; namely, $62.50 for the round trip from that city with $15 extra if the party returns via the northern routes. There will be $6.50 extra railway fare on the side trip to the Grand Canyon. The berth rate from Chicago to San Francisco will be $14 with an additional charge for the four extra days in transit in lieu of hotel expenses, as the Pullmans will be used throughout the trip. This additional charge will approximate $7 on the berth rate.

The Puget Sound Section are hoping that a considerable number of the members may decide to return via Seattle and if a party can be formed they will make every effort to show us their own delightful surroundings.

In view of the efforts that are being made by the California members and of the unusual attractions of the trip, it is hoped that a special effort will be made by eastern members to be present at the meeting. Reservations for the special train will be made in the order of their receipt. Any members of allied societies going west at this time who may wish to share in the privileges of the special train should address the secretary, Charles L. Parsons, New Hampshire College, Durham, N. H.

SCIENTIFIC NOTES AND NEWS

Before the Paris Academy of Sciences on March 4, M. Picard made a eulogy on the late Alexander Agassiz. Mr. Agassiz had attended a meeting of the academy two weeks previously.

The will of Alexander Agassiz, dated September 17, 1906, was filed at Newport, on April 14. He bequeathed $200,000 to Harvard University, half for the Museum of Comparative Zoology and half for its publications. The university also receives scientific apparatus and books, and will ultimately receive the further sum of $12,000. Mr. Agassiz further bequeathed $50,000 to the National Academy of Sciences and an equal sum to the American Academy of Arts and Sciences. $25,000 is left to the Newport School of Manual Training, to which ultimately $6,000 will be added. Mr. Agassiz's will further provides that in the case of the death of any one of his three sons without issue his share of the estate shall ultimately go to Harvard University for the Museum of Comparative Zoology.

On the occasion of the retirement of Dr. Charles F. Chandler, head of the Department of Chemistry of Columbia University, a testimonial is to be tendered in his honor under the auspices of the Chemists' Club, the Society of Chemical Industry, the American Chemical Society, the American Electro-Chemical Society, the American Institute of Chemical Engineers and the Verein Deutscher Chemiker. The form of the testimonial has been arranged as follows: first, a banquet at the Waldorf-Astoria, on Saturday, April 30, at 7 P.M.; second, the presentation of a bronze bust in heroic size, to be executed by Mr. J. Scott Hartley, which bust it is expected will finally be presented to the Chandler Museum of Columbia University, while a replica will be presented to Mrs. Chandler, and third, the creation of a Chandler testimonial fund for the purpose of purchasing books for the library of the Chemists' Club. Subscriptions for the dinner (five dollars) and to the testimonial may be sent to the treasurer of the committee of arrangements, Dr. Morris Loeb, 273 Madison Avenue, New York City.

Sir William Ramsay will be president of the British Association for the meeting to be held next year at Portsmouth.

On the occasion of the installation of the Duke of Devonshire as chancellor of the University of Leeds, on June 11, the degree of doctor of science will be conferred on Lord Rayleigh, Sir Clements Markham and Dr. Osler.

The Royal College of Surgeons of England has awarded a gold medal to Dr. Robert Fletcher, principal assistant librarian of the library of the surgeon general's office in Washington, in recognition of his services in connection with the indexing of the catalogue of that library.

The Philadelphia Geographical Society has conferred its gold medal on Commander Robert E. Peary, who lectured before it.

Sir Harry Johnston, G.C.M.G., has been elected a corresponding member of the Italian Geographical Society.

A Malacological Club has been formed at Boston, with Professor E. S. Morse as the first president.

President Charles R. Van Hise, of the University of Wisconsin, will attend the International Geological Congress at Stockholm, Sweden, this summer, sailing from Quebec on July 1 for Liverpool. He may be accompanied by Professor C. K. Leith of the geological department.

Dr. George Grant MacCurdy has been appointed to represent Yale University at the International Congress of Americanists to be held in the City of Mexico, September 8 to 14, 1910.

Professor Poulton, F.R.S., Dr. Dixey, fellow of Wadham College, and Dr. Malcolm Burr, New College, have been appointed as representatives of Oxford University at the International Congress of Entomology to be held at Brussels in August next.

Dr. Arthur Twining Hadley, president of Yale University, has accepted an invitation to deliver the golden jubilee address before the University of California on May 17.

The council of the Institute of Metals, London, has initiated an annual series of May lectures. The first will be given on May 24 by Professor W. Gowland, F.R.S., on "The Art of Working Metals in Japan."

Professor William Graham Sumner, of Yale University, eminent for his contributions to sociology and economics, died on April 12, at the age of sixty-nine years.

The Rev. Jeremiah Lott Zabriskie, known for his work in entomology and microscopy, died at his home in Brooklyn, on April 2, at the age of seventy-five years.

Sir Robert Giffen, the eminent British statistician, died on April 12, at the age of seventy-three years.

Professor Julien Fraipont, rector of the University of Liége, well known for his writings on anthropology and geology, died on March 22 in his fifty-third year.

Mr. Adolph Lewisohn has given $130,000 to Mt. Sinai Hospital for the erection of a pathological laboratory.

We learn from *Nature* that the valuable collection of shells formed by the late Mr. Thomas Gray, of Glasgow, who died recently at the advanced age of eighty-nine, has been left by him to Kelvingrove Museum, Glasgow. More than 7,000 species of shells are represented in the collection.

Professor Hilary Bauerman, of London, who died on December 5, aged seventy-five, leaving an estate of the value of £15,000, bequeathed £500 to the memorial fund of the Iron and Steel Institute. The residue of his property he left subject to a life interest, to be applied in the encouragement of the study of mineralogical science at the Royal School of Mines.

President Taft sent to congress on April 9 a message recommending an appropriation of $50,000 for a laboratory in which to conduct investigations on cancer. "The very great importance of pursuing the investigation into the cause of cancer," said the president, "can not be brought home to the congress or to the public more acutely than by inviting attention to the memorandum of Dr. Gaylord herewith. Progress in the prevention and treatment of human diseases has been marvelously aided by an investigation into some diseases in those of the lower animals which are subject to it, and we have every reason to believe that a close investigation into the subject of cancer in fishes, which are frequently swept away by an epidemic of it, may give us light upon this dreadful human scourge."

Cincinnati's city council has repealed the ordinance passed a year ago whereby "more daylight was to be gained for workers by setting local clocks two hours fast from May to October of each year."

A letter has been received from Professor E. B. Frost, director of the Yerkes Observatory, regarding recent observations of Halley's Comet made at that place. On April 12 Professor Frost found the comet more conspicuous than the adjacent star *c Piscium,* and Professor Barnard estimated the nucleus, which was not stellar, to be two magnitudes fainter than this star. On April 14 the comet was photographed with 6 m. exposure. No tail was visible with any of the instruments. Visual observations of the spectrum were made by Professor Frost and Dr. Slocum, and showed a distinct continuous spectrum from the nucleus. No bright bands or lines were seen. The intensity of the continuous spectrum, relative to the emission bands, has greatly changed since the comet was visible in the evening.

The Harpswell Laboratory, at South Harpswell, Me., will be open to investigators during the present summer from June 20 until September 1. Owing to the absence of Dr. Kingsley in Europe it will be under the charge of Professor H. V. Neal, of Knox College, Galesburg, Ill., to whom all communications and applications for places should be addressed. Thanks to the participation of several colleges and universities, the laboratory is in a position to offer its facilities free to all who are desirous of carrying on investigations on the northern fauna or flora. There are only nine rooms available for students, and as some of these are already engaged, an early application for places is advisable. No circulars will be issued this year.

The seventh annual session of the Puget Sound Marine Station, located at Friday Harbor in the State of Washington, will commence on June 28 and continue till August 8, 1910. This station, which is conducted upon a cooperative basis through the affiliation of a number of the educational institutions of the northwest, will open this season with greatly increased facilities. A laboratory building is under construction which will be available for use at the beginning of the coming session. This structure will be provided with running water, both fresh and salt, research rooms for investigators, dark room for photography, facilities for elementary instruction and a small but well selected library bearing upon the natural history of the northwest. The equipment includes a steamer fitted with dredging apparatus for deep water work and small boats for shore collecting. Provision has been made for elementary classes as well as for advanced students and for investigators who wish to pursue individual re-

searches. Among those who will offer courses at the station during the coming session are the following: Trevor Kincaid, professor of zoology, University of Washington; Nathaniel L. Gardner, acting professor of botany, University of California; W. J. Baumgartner, assistant professor of zoology, University of Kansas; Geo. B. Riggs, assistant professor of botany, University of Washington; W. L. Moodie, instructor in botany, Bellingham State Normal School; F. A. Hartman, instructor in zoology, Seattle High School. For those wishing to investigate the marine fauna and flora of the northwest coast the Puget Sound Marine Station, located in the midst of a picturesque archipelago of rocky islands, offers an unsurpassed opportunity. Further information with regard to the station will be supplied by the director, Professor Trevor Kincaid, University of Washington, Seattle, Wash.

UNIVERSITY AND EDUCATIONAL NEWS

Johns Hopkins University has received an offer of $250,000 from the General Education Board for the purpose of aiding the university in its efforts to put into operation certain extensions and improvements that have been under consideration for several years, including the erection of new buildings on the Homewood site. This sum will be contributed conditional on the raising of a supplementary sum of $750,000 by the university by December 31, 1910. The university, however, is endeavoring to raise $2,000,000, half for new buildings, while the other $1,000,000 will be used for endowment. Among the extensions contemplated are a school of engineering; a law school; a training school for teachers; a department of preventive medicine, and a building for pathology.

A joint hearing on the bills to appropriate $652,000 for new buildings for the College of Agriculture and $130,000 for new buildings for the Veterinary College at Cornell University was given on April 5 by the finance committee of the senate and the ways and means committee of the assembly. Thirty-six persons spoke in favor of the bills and nobody appeared in opposition to them. From the standpoint of the colleges addresses were given by Acting Director H. J. Webber, Dr. V. A. Moore and Director L. H. Bailey. The hearing was closed by President Schurman's address summarizing the argument.

Dr. Cheesman A. Herrick, formerly principal of the William Penn high school for girls, was installed as president of Girard College on April 2.

Dr. Albert E. Giescke, an American and a graduate of Cornell University in political science, has been elected rector of the University of Cuzco, Peru. This university was founded by a papal decree of 1692. Dr. Giescke went there as a member of the faculty in 1908.

At Stanford University appointments have been made as follows: E. W. Ponzzer, of the University of Illinois, assistant professor of applied mathematics; Hans Zinsser, instructor in bacteriology in Columbia University, associate professor of bacteriology; Frank P. Blaisdell, assistant professor of anatomy; David M. Folsom, assistant professor of mining; Galen H. Clevenger, assistant professor of metallurgy; Rufus C. Bentley and Lewis M. Terman, assistant professors of education. As instructors have been appointed Perley A. Ross, in physics, and George F. McEwen, in applied mathematics. The following promotions have been made: George C. Price, now associate professor, to be professor of zoology; George J. Peirce, now associate professor, to be professor of botany; William A. Hillebrand, now instructor in electrical engineering, to be assistant professor; Royce R. Long, now instructor in physical training, to be assistant professor; Luther W. Bahney, now instructor in metallurgy, to be assistant professor.

DISCUSSION AND CORRESPONDENCE

THE GERM THEORY OF DISEASE

In Science for April 1, p. 500, Dr. Fielding H. Garrison has pointed out the true author of the germ theory. We can readily accept this until an earlier author is discovered by some one. Knowledge in most cases seems to

be built up from the investigations of a number of observers. Dr. Garrison closes his very interesting account by saying: "But no one ever thought of mosquitoes in relation to yellow fever before the time of Finlay and Walter Reed." Dr. Reed and his associates proved the theory, which was the all-important event, but it may not be amiss to call attention to an article published by Dr. Josiah C. Nott in 1848. He was evidently a learned physician of wide experience, a keen observer and reasoner, and in addition had a profound knowledge of the literature of zoology, particularly entomology. To what extent he anticipated present knowledge of the mosquito transmission of yellow fever may be somewhat a matter of opinion. The article is a most interesting one and will well repay perusal. It should be read in its entirety to get the proper conception of it and realize to what a remarkable degree the man was ahead of his day. The title is "Yellow Fever contrasted with Bilious Fever—Reasons for believing it a disease sui generis—Its mode of Propagation—Remote cause—Probable insect or animalcular origin, etc., by Josiah C. Nott, M.D., Mobile, Alabama. New Orleans Medical and Surgical Journal, IV., pp. 563–601, 1848." A few extracts may prove interesting, as this journal is not accessible to many persons.

I propose to now show, from facts presented during the various Epidemics in Mobile that the morbific cause of Yellow Fever is not amenable to any laws of gases, vapors, emanations, &c., but has an inherent power of propagation independent of motions of the atmosphere, and which accords in many respects with the peculiar habits and instincts of insects. . . . There are even perfectly authenticated instances where one side or end of a ship has suffered severely from this disease, whilst the other was entirely free from it! We can readily believe, that certain insects which are endowed with unaccountable instincts and habits might attack a part of a ship, or a tree, of a wheat or cotton field; but we can not imagine how a gas could be turned loose on one side of the cabin of a vessel and not extend to the other. . . . Yellow Fever can not be explained by the malarial[1] theory, and it must remain with the reader to determine whether the chain of analogies offered, render the Insect theory more probable. . . . With these facts before us, how much more easily may we account for the spread of yellow fever from a focus, by the insect, than by the malarial[1] hypothesis—here is something tangible and comprehensible.

[1] Used in the sense of bad air.

In regard to cholera he says: "The history of these great epidemics which sweep over the surface of the globe affords very strong support to the Insect theory." Dr. Nott's remarks on vessel quarantine are in absolute accord with the knowledge and practise of to-day.

HENRY SKINNER

THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA

DOES EXCESSIVE LIGHT LIMIT TROPICAL PLANKTON?

TO THE EDITOR OF SCIENCE: Among the numerous explanations of the richness of polar seas in plankton and the poverty of tropical waters, I fail to see any mention of the lethal effect of excessive light, yet this effect is so well known that we make daily use of sunlight to destroy pathogenic organisms, all of which flourish in the dark only. The tropics are rich in all land forms, but in every case there is some provision by which the protoplasm is protected from excessive light, and, as a matter of fact, the ordinary bacteria of northern latitudes do not flourish in the tropics. In the waters, on the other hand, unpigmented forms have nowhere to hide, as in caves, crevices, under rocks or under the shade of pigmented ones, except as parasites in the bodies of multicellular organisms, and must perish through this disinfecting power of the sun's rays. The same phenomenon has been found by the metropolitan sewage commission in the waters of New York harbor, where the winter flora derived from sewage is far richer than the summer.

The vernal increase of phyto-plankton in northern waters is the same phenomenon as the vernal increase of land plants—due to the return of the sun with non-lethal amounts of light which are utilized in the decomposition of carbon dioxide by the chlorophyl. To be sure, the increased temperature of the air is the main reason for renewed protoplasmic ac-

tivity of land forms in spring, but Herdman says[1] that "the temperature of the sea-water, however, appears to have little or no effect in determining the great vernal maximum of phyto-plankton." From this it is presumed that the richness decreases in the summer in spite of the warmer water, because the light becomes more or less destructive. It must be remembered that at 70° of north latitude the midday sun is just as strong on June 22 as it is at the tropic of cancer December 22.

There seems to be great confusion in literature on the effects of light, due to failure to distinguish between these two entirely distinct phenomena—(1) the stimulating or actinic effect on the living protoplasm and (2) the use of the energy of the rays to break up carbon dioxide in the chlorophyl-bearing cells. Plant-cells, as a matter of fact, like bacteria, function in absolute darkness, under the bark or in the roots, and do not need the slightest stimulation of light, indeed are killed by it, as a rule. Light is only used to build up the carbon food, and the cells engaged in this duty are also protected by the green pigment, hairs, etc., but even they are killed by two much light, as the botanists show—each species having its own danger limit which in the shade-loving plants is a very low one. Indeed, in botanical literature there are increasing numbers of references to the fact that the effect of light on plant protoplasm is to retard growth; while the effect on the chlorophyl is to supply carbon food for the cells under the bark.

It is quite evident, then, that the return of light in the spring starts the phyto-plankton to grow and multiply by furnishing more nutrition, but when the light gets so intense that it can penetrate in harmful degree to the protoplasm, growth is checked.

Dr. C. Stuart Gager's experiments with radium[2] are reported to show that in minimal amounts these powerful rays do not penetrate sufficiently to have any effect on the plant protoplasm, but above this minimum and up to an optimum they stimulate all functions. Beyond the optimum and up to the maximum their effect is a retardation or distortion of function, and beyond the maximum it is lethal. This is precisely the conclusion from the innumerable observations and experiments of the effects of light and ultra-violet on protoplasm of animals adjusted to a life in the light—man particularly—though as a matter of fact the stimulation of small amounts of light is not a vital necessity, as shown by the animals which have taken up residence in the deep sea or dark caves or have developed a nocturnal habit.

Curiously enough, though there are innumerable observations on the effects of minimal, optimal and maximal amounts of light on the plant as a whole, there are none which differentiate between the effects on the chlorophyl activity and the effects on the protoplasm. The radium rays have no known effect on the synthesis of the carbon compounds—the only rays effective there are small bands in the red or blue or both, and varying with different species. The radium effects are solely due to their influence upon the protoplasm under the bark. On the other hand, the well-known nocturnal growth of plants exposed to electric light is solely due to the increased food synthesis in the leaf, for it is not possible for these rays to penetrate the bark to effect the other cells which constitute the plant and construct its materials. It is so manifestly difficult or impossible to get light to penetrate bark evolved for the very purpose of excluding it, that we probably never shall know exactly how the various intensities of light affect the protoplasm of the higher plants, beyond the one undoubted fact that in amounts sufficient to penetrate thin skins it invariably retards growth or kills. In the case of unprotected unicellular plants, the case is different, and it is known that some species are injured by light in any amount, others seem to thrive best in dim light, while all are injured and killed by an excess, which varies with the species.

The behavior of phyto-plankton then according to the light of climate, latitude and season seems to follow all other forms of

[1] Science, November 26, 1909.

[2] *Memoirs of the N. Y. Bot. Garden*, Vol. IV., 1908.

protoplasm. Indeed it ought to be safe to predict that the vernal increase in northern waters will continue throughout the summer wherever there is much cloudiness to temper the lethal effects of the midday sun. Perhaps this fully accounts for the wonderful fisheries in northern cloudy, misty, foggy latitudes, rich phyto-plankton serving as food to minute animals, these as food for larger, and so on up to those edible varieties upon which so many millions of people subsist.

It is to be hoped that there will be renewed activity in studying the effects of light on plant protoplasm regardless of its effect on the leaf activities. There is opportunity for valuable deductions applicable to man, for we are finding that the effects of excessive light on unprotected migrant types are much more profound than we formerly believed possible, and there is room for improvement in daily hygiene in the interests of the preservation and eugenic development of these types. The fact that plants depend upon light to enable them to get their carbon food has concealed the fact that it is a lethal agent to naked protoplasm. The medical profession is slowly realizing the dangers of excess, but to place the matter on a sounder and more exact basis, we need more investigations, particularly on plants such as the plankton and the land forms of the lower orders.

The matter is becoming of great economic importance, not only from the fact that life insurance companies are finding less expectancy of life in northern Europe ethnic types too greatly out of adjustment to American climates, but Retzius, in a recent address to the British Anthropological Institute, has called renewed attention to the long-known fact that the northern blond type is unfit for modern industrial life which is being carried on by the brunet races. It has also long been known that the blond types evolved for survival in northern outdoor employments in the cloudy northwest corner of Europe, are so injured by city life, that even as far north as Glasgow, Scotland, they are being rapidly replaced by the brunets, who in some way are better guarded against factors fatal to the others. The disappearance of the blond type, which Retzius predicts, is of course a baseless absurdity. Indeed their numbers are constantly increasing in Europe where they can live, and immigration keeps up the proportion here in spite of their higher death rate. It is possible to lengthen their average life here, if we will only realize what injures them. The premature death of such great men as the late Governor Johnson of Minnesota has a lesson which American anthropologists should heed now that Retzius and Beddoe have led the way. But nothing can be done as long as we consider man so supernatural that he is the only species of living thing whose characters, such as pigmentation, are meaningless freaks of no survival value—an absurd view for which the pre-Darwinian anthropologists are responsible—a view also derived from the old theory that all present-day types are degenerate forms of prehistoric perfect adamites.

So it is of much importance that all vital phenomena in any way related to light intensity should be investigated and explained. The profusion of plankton in northern climates and particularly in the cloudy and foggy places, such as the North Sea and Banks of Newfoundland, is therefore a more interesting and important phenomenon than our biologists seem to realize. In "The Effects of Tropical Light on White Man," published in 1905, I collected all available data then found, but in the succeeding five years much more have been published which show that all racial characters have survival value and some of them are so important as to fit a type for a very limited environment. Pigmentation is of this nature, and so important that its absence is a bar to survival if the type migrates to a very light country. In every known case of survival of the migrated blond race, it is found to be due to the fact that it is in the cloudy mountains such as the Alps, or in northern Italy and Spain, even though it be found by the side of brunets. It is not then such a far cry from the northern richness of phyto-plankton to the existence of large numbers of the sea-faring, Baltic type of man.

Chas. E. Woodruff

ATTENDANCE AT THE GRADUATE SCHOOL OF HARVARD UNIVERSITY

TO THE EDITOR OF SCIENCE: Permit me to call the attention of your readers to a misstatement that appeared in the issue of December 24, 1909, to the effect that the attendance on the graduate school of Harvard University showed a loss as compared with the previous year. The error arose from the fact that in the figures for 1908 the graduate students at Radcliffe were included under Graduate Schools, whereas they were omitted in 1909 under the caption of graduate faculties, but included under women undergraduates. On November 1, 1908, there were 450 students at Radcliffe, of whom 394 were undergraduates and 56 graduates. Adding the latter to the enrollment in the Graduate School of Arts and Sciences gave a total of 460. On November 1, 1909, there were 464 students at Radcliffe, of whom 402 were undergraduates and 62 graduates. Adding the latter to the enrollment in the Graduate School gives a total of 485, representing an increase of 25 over the figures of 1908. This year's attendance on the Graduate School of Arts and Sciences is the largest in the history of the institution.

RUDOLF TOMBO, JR.

COLUMBIA UNIVERSITY

SCIENTIFIC BOOKS

Encyclopédie des Sciences Mathématiques pures et appliquées, publiée sous les auspices des Académies des Sciences de Gottingue, de Leipzig, de Munich et de Vienne, avec la collaboration de nombreux savants. Édition française, rédigée et publiée d'aprés l'édition allemande sous la direction de JULES MOLK. Tome I., volume I., Arithmétique. Paris, Gauthier-Villars; Leipzig, B. G. Teubner. 1904–.

It is customary to await the completion of a work before writing a review of it, but unusual conditions frequently call for unusual action. The greatness of the work before us and its wide range of contact with subjects familiar to all educated people seem to justify a brief review at this stage of its development; especially since such a review may be of service to many who wish to take advantage of the various parts of the work as soon as possible, and since a large amount of work remains to be done before this first volume can be completed, although more than 600 pages of it have been published.

The German work upon which this French edition is based is the work of scholars of many different nations, so that the present work is decidedly international and it is appropriately issued by the two leading mathematical publishers in the world. The object of the German edition is to give as completely as possible the fully established mathematical *results* and to exhibit, by means of careful references, the historical development of mathematical *methods* since the beginning of the nineteenth century. The work is not restricted to the so-called pure mathematics, but it includes applications to mechanics, physics, astronomy, geodesy and the various technical subjects, so as to exhibit *in toto* the position occupied by mathematics in the present state of our civilization.

The French edition aims to retain the essential traits of the German, but it is not merely a translation with the addition of more recent references. On the contrary, it takes account of the French traditions and habits as regards lucid exposition and it treats many subjects very much more extensively than the German edition, while other subjects receive practically the same treatment in the two editions. Both editions are issued in parts—the first parts of the German edition were published in 1898, while those of the French began to appear six years later. The German edition has the advantage of much greater progress towards completion, while the French has a decided advantage as regards exhaustive treatment and more recent references, although these advantages are partly offset by the fact that the additions make the work more voluminous and hence less convenient as a work of reference.

Notwithstanding the fact that the Germans have acted as pioneers in this vast undertaking and have partially prepared the way for the French, yet the latter have had no easy task before them, and in some cases they have done

so much more than their predecessors that the work appears almost new. To what extent this is true as regards the volume before us may be inferred from the number of pages which the French and German editions respectively devote to the various subjects considered in the published parts of this volume. The subjects and numbers of pages in the two editions are as follows, the first number applying to the French edition: Fundamental principles of arithmetic 62, 27; Combinatory analysis and determinants 70, 19; Irrational numbers and convergence of infinite processes with real numbers, 196, 100; Ordinary and higher complex numbers 140, 37; Infinite algorithms with complex numbers 20, 8; Theory of sets 42, 24; Finite discrete groups 85, 19. Hence the total number of pages devoted to arithmetic in the published parts of the French edition is 615, while the German edition devotes only 234 pages in all to this fundamental subject. The article on finite groups is the only one which is avowedly left unfinished in the parts of the French edition already issued, but additions to other articles are also to be made before volume I. is completed.

The list of subjects enumerated in the preceding paragraph constitutes *arithmetic*, the mother queen of mathematics, according to the best mathematical encyclopedia; and this list should be of interest to every educated person as indicative of what are regarded to be the most fundamental mathematical subjects by such an eminent tribunal. As the term arithmetic is now generally employed by mathematicians to include the most basal subjects of pure mathematics, and is not restricted to things which deal directly with numbers, it is of great interest to compare the classifications by eminent authorities and to observe that such new subjects as the theory of sets and the theory of discrete groups of finite order are accorded a place among these basal sciences. It is also of interest to observe that the latter of these subjects is accorded relatively the largest increase of space in this first volume of the French edition as compared with the German. This is partly due to the fact that the literature of this theory has grown very rapidly during the last decade, and partly to the fact that this subject was given a disproportionately small amount of space in the German edition.

It is to be hoped that the present work will have a large circulation in this country, as it will doubtless be a standard for many years. Even those who have only a slight knowledge of the French language will be able to use it to great advantage, as the mathematical notation is practically cosmopolitan. The historical notes and references are especially complete and many of those relating to elementary arithmetic are of interest to teachers of this subject in the secondary schools. It is scarcely necessary to call the attention of the professors of mathematics in our colleges and universities to this work, since most of them have learned to appreciate the German edition and can not fail to appreciate still more an edition offering so many important improvements. While the specialist does not always know everything relating to his subject, it will probably be considered as almost unpardonable if any scholar displays ignorance of what this encyclopedia contains along the line of his chief interest.

Fortunately the volumes are sold separately so that those who may not wish to subscribe for the entire work can procure those volumes in which they may be chiefly interested. The remaining part of volume I. as well as the remaining parts of the other three volumes of Tome I. are, to a large extent, in press and will probably be published within a few years. The second and third of these volumes are devoted respectively to algebra and to the theory of numbers, while the fourth is devoted to the calculus of probability, theory of errors and diverse applications. In addition to the remainder of the article on finite groups, the volume under review is to contain the following: Complements on all the articles in the volume, bibliographical lists of the principal works treated in these articles, lists of the principal technical terms in the four languages, English, French, German and Italian, and the usual subject and author indexes together with a preface and an introduction.

The four parts of this volume which have appeared bear the following dates, respectively: August, 1904, May, 1907, April, 1908, and August, 1909.

The complete encyclopedia is to appear in seven tomes, each consisting of several volumes, probably ranging from three to five. The first three tomes are to be devoted to pure mathematics, while the following three are to treat the applications of mathematics. The seventh and last tome is to be devoted to historic, philosophic and didactic questions. As a large number of eminent French mathematicians are engaged on the preparation of this edition, its completion within a reasonable number of years seems to be assured and the high standard set by the dozen parts which have already appeared, although they are not free from serious errors, promises to be maintained in the future issues. If this is done the work will be indispensable, not only in the larger scientific libraries, but it will also be one of the most frequently consulted works in many private mathematical libraries. Those who do not have easy access to a large library will frequently find in this work sufficient references to guide them safely in their investigations. It is to be hoped that in this way it will serve as a powerful stimulus to mathematical progress in the highest and widest sense.

G. A. MILLER

UNIVERSITY OF ILLINOIS

Crystalline Structure and Chemical Constitution. By A. E. H. TUTTON, D.Sc., M.A. (Oxon.), F.R.S., A.R.C.S. (Lond.), Vice-president of the Mineralogical Society; Member of the Councils of the Chemical Society and of the British Association for the Advancement of Science. Cloth, 6 × 9, pp. viii + 200, figures 54. London, Macmillan and Co., Limited, 1910. $1.50 net.

This interesting volume presents in condensed and connected form the results of a series of investigations in physical crystallography carried out by the author during a period of some twenty years, having for its object the establishment upon the most accurate observational data of the exact relations existing between the chemical constitution and the crystalline form and properties of a series of related compounds.

These investigations consisted of three related parts: namely, the devising of new instruments capable of making more accurate observations than had hitherto been possible in this field; the perfection of methods of preparing crystals for investigation, and the actual measurements of the crystal angles and other constants.

The instruments devised, the description of which occupy chapters V., VI., VII., VIII. and IX., include a *cutting* and *grinding goniometer* so arranged that the small and soft artificial crystals employed could be cut and polished with absolute control of the direction of the artificial surface; the *spectroscopic monochromatic illuminator* to secure for the optical measurements monochromatic light of any desired wave-length; the *interferometer*, an instrument for fine measurements of length by the interference method, employed by Tutton as the essential optical part of the *dilatometer* for measuring the thermal expansion of crystals and of the *elasmometer* for measuring their elasticity by determining the amount of bending which a plate of the crystal undergoes at the center when supported near its ends, under the influence of a weight applied at the center. By means of these highly elaborate instruments the author considers that he has raised the accuracy of goniometric measurements to the level on which atomic weight determinations now stand and the measurements of the physical constants of crystals to the degree of accuracy of wave-length determinations by the interference method.

The materials studied include some 54 salts in two series; the simple anhydrous sulphates and selenates of potassium, rubidium, cæsium, ammonium and thallium, 10 in number; and the double hydrous sulphates and selenates of the above five elements with each of the metals magnesium, zinc, iron, nickel, cobalt, copper, manganese and cadmium, of which 44 were prepared. Many crops of crystals of each salt

were prepared under varying conditions and tested by chemical and spectroscopic methods with utmost refinement as to purity. Not less than 10 crystals of each were measured for crystallographic form and constants and about twelve orientated sections or prisms of each were measured at various temperatures and for six wave-lengths of light in determining the indices of refraction. Determinations of the volume of each salt were also made with great exactness, and the solubility of each in water established. The enormous amount of exacting labor represented by these researches will be abundantly clear to any one who has made such a study of even a single substance.

In chapter X. are presented the results obtained in goniometrical examination of both the normal sulphates and selenates, or orthorhombic series of crystals and of the double sulphates and selenates or monoclinic series.

Chapter XI. treats of the volume relationships of the simple and double sulphates and selenates and the conception of molecular distance ratios or topical axes.

Chapter XII. presents the optical relationships of the two series of sulphates.

Chapter XIII. is devoted to an explanation of the phenomenon of crossed-axial-plane dispersion of the optic axes which is shown to be "due to very low double refraction, combined with close approximation of the intermediate index of refraction to one of the extreme indices; and to the fact that change of wave-length of light or change of temperature, or both, cause the intermediate index to approach still nearer to the extreme one in question until it becomes identical with it, and eventually to pass it, the relative positions of the two thus becoming reversed." The experimental evidence leading to this explanation is beautifully clear.

In chapter XIV. the results of the thermal investigation of the sulphates is presented, and in chapter XV. a summing up of the chief results of the investigations. This summary seems of sufficient interest to justify somewhat extensive quotation, as it appears to be the clearest statement yet given of just what the modern concept of isomorphism involves.

The crystals of the different members of the rhombic series of isomorphous sulphates and selenates of the alkalies,

$$R_2\left\langle\begin{matrix}S\\Se\end{matrix}\right\rangle O_4,$$

and those also of the monoclinic series of double sulphates and selenates,

$$R_2M\begin{pmatrix}S\\SeO_4\end{pmatrix}_2.6H_2O,$$

while conforming to the same symmetry—that of their particular isomorphous series—and exhibiting the same facial forms inclined at angles which never differ by more than one or two degrees, exhibit progressive variations in their exterior geometrical configurations, interfacial angles and crystallographic elements, in their internal structural properties and constants of which the external form is only the outward symbol, in their optical characters and in their thermal behavior; and these variations follow the order of progression of the atomic weights of the three alkali metals belonging exclusively to the same family group of the periodic classification, potassium, rubidium, cæsium, which by their interchange give rise to the series. The variations are, therefore, functions of the atomic weight of the alkali metal. . . . Similar variations attend the replacement of sulphur by selenium in the acid radicle present in the salts.

The thallium and ammonium salts of the two series exhibit properties fully entitling them to inclusion in these respective series of isomorphous salts, understanding by the term "isomorphous series" a series, the members of which bear a definite chemical analogy, crystallize with like symmetry and develop forms the interfacial angles of which differ only by an amount which has not yet been observed to exceed 2½ degrees. The more exclusive "eutropic series" within each of these isomorphous series, that is to say, the series in which the members exhibit the progression of the whole of the crystal properties according to the atomic weight of the interchangeable chemical elements, comprises solely the salts of the alkali metals K, Rb and Cs which belong strictly to the same family group of the periodic classification, the thallium and ammonium salts being excluded by their essentially different chemical nature and their different crystallographic properties which follow therefrom.

Finally, a third general conclusion is drawn:

Specific chemical substitutions are accompanied by definitely orientated changes of the crystal structure, indicating that particular chemical atoms occupy definitely localized positions in the chemical molecule, and therefore, as the molecule is the structural unit of the space-lattice, in the crystallographic structural unit.

This last principle, first definitely established by these researches, is regarded by the author as the most marked step in advance he has made.

Despite its highly specialized character the book is written in a style that is delightful and should surely be in the possession of every student of physical crystallography.

CHARLES PALACHE

Elements of Mineralogy, Crystallography and Blowpipe Analysis from a Practical Standpoint. By ALFRED J. MOSES, E.M., Ph.D., Professor of Mineralogy, Columbia University, and CHARLES L. PARSONS, B.S., Professor of Chemistry, New Hampshire College. Fourth edition, with 448 pages of text and 583 figures. Cloth, $6 \times 9\frac{1}{4}$. New York, D. Van Nostrand Company. 1909. $2.50 net.

The fourth edition of this well-known textbook differs in no essential matters from the previous edition. The statistics of production of minerals of economic value have been revised, the figures given being those for 1907 and in part 1908. The book gives an excellent presentation of the main facts of mineralogy and deserves to be, as it doubtless is, largely used by teachers of the subject.

It is unfortunate that advantage has not been taken of the opportunity offered by this new edition to improve some of the very poor illustrations that mar certain pages, as well as to eliminate several confusing errors in the crystallographic figures and lettering.

CHARLES PALACHE

Indian Insect Life. A manual of the insects of the plains (Tropical India). By H. MAXWELL-LEFROY, Entomologist, Imperial Department of Agriculture for India, and F. M. HOWLETT, 2d Entomologist, published under the authority of the Government of India, Agricultural Research Institute, Pusa. 4to, pp. 786, plates 84 (many colored), text figures 536. Calcutta and Simla, Thacker, Spink & Co.; W. Thacker & Co., 2 Creed Lane, London. 1909.

This attractive and well-illustrated volume gives, in convenient form, a summary account of the varied insect life of tropical India, in particular. This limitation necessarily precludes the discussion, except in an incidental manner, of the splendid fauna of the Himalayan region. There is much of interest in the work for the professional entomologist, while the amateur will find a large number of the more conspicuous or common insects noticed, accompanied in many instances by facts of great practical value.

The author finds it convenient to treat the varied forms under nine orders, namely, Aptera, Orthoptera, Neuroptera, Hymenoptera, Coleoptera, Lepidoptera, Thysanoptera, Diptera and Rhynchota (Hemiptera) following, in a large degree, the classification adopted by Sharp. The author's aim has been to produce a readable, convenient volume rather than to rigidly follow a classification with possible inconvenience to his readers. The introduction gives some observations upon the principles of classification, the relation of instinct and habit, the sources of information, and a discussion of the zoogeographical divisions of India, the faunal limits of the work thus being plainly defined. At the outset, insects are roughly classified according to food habits, they being divided, for example, into fruit insects, seed-eating insects, flower insects, etc. There is an illuminating chapter on insects and their relations to man, a much more vital topic in the tropics than in the temperate zone.

The space given to the discussion of the orders is necessarily unequal, owing to the fact that representatives of many Indian groups are comparatively unknown. A most attractive feature for the general student is found in the independent chapters or interludes dealing with such topics as: Where Insects Live, Cosmopolitan Insects, Deceptive Coloring, Relative Duration of Life, Insects and Flowers, How Insects Protect Themselves, etc., each of these summarizing from the en-

tire class. The discussion of the various orders or groups is frequently supplemented by brief observations on collecting methods, a most suggestive departure for the amateur. One of the strong features of the work is the extended discussion of the termites, a very important group in tropical countries. The chapter on galls (p. 167) might possibly have been amplified to advantage, since there are a large number of species known to produce deformities in plants. It is doubtful if the author's generalization to the effect that the parent gall insect stimulates the tissues to an abnormal growth, will be sustained by a reexamination of the facts. The paragraphs dealing with the fig insects are of special interest to Americans since the establishment of Blastophaga on the Pacific coast. Another statement open to question is the author's assertion (p. 191) to the effect that there is no real information as to how the two sexes find each other. We are under the impression that some experiments[1] demonstrate beyond all question that certain male insects find their mates through the highly developed, olfactory organs of the antennæ. The observations on the methods employed by Salius (p. 196) in capturing its prey, are particularly commendable. The plugging of rifle barrels with clay, by Sceliphron (p. 207) appears to be a novel record and the same is true of the wasp, *Icaria ferruginea* (p. 215), rendering houses uninhabitable. It is interesting to note that *Xylocopa* on the plains and *Bombus* in the hills, are the dominant flower-visiting insects, the latter being comparable to American conditions. The practicability of using one insect to fight another is strikingly illustrated by the natives employing certain species of true ants to check the depredations of white ants. Similarly, the author mentions the introduction in the Hawaiian Islands, of species of dung beetles, in the hopes that by quickly destroying the droppings of cattle they would abate the plague of horn flies. The chapter on insects as food is exceptionally full and certainly timely, in view of the high price of meat. There seems to be no reason, as observed by the author, why man should "refuse to consider a nice, clean, white termite queen or a dish of locusts" when he includes in his diet shrimps, whelks and even dried sea slugs. A practical suggestion for protecting wood from borers is found in the fact that general experience in India has demonstrated the value of soaking bamboo in water prior to using it for structural work, for the purpose of preventing attack by scolytids. This latter group, despite its importance in temperate regions, receives scant notice.

[1] 1900, Mayer, A. G., *Psyche*, 9: 15–20; 1906, Folsom, J. W., "Entomology," pp. 102–103.

The discussion of the Lepidoptera is relatively full and very satisfactory as a whole, though it is difficult in a work of this character to preserve a satisfactory proportion between the various parts. The large and attractive Bombycidæ, such as *Actias*, *Antheræa* and *Attacus* come in for their full share of attention. In connection with these forms there is an excellent discussion of the production of silk by insects, together with notes on its composition and a technical description of the four commercial Indian silks. The Microlepidoptera of India appear to be relatively unknown for the most part, judging from the fact that the discussion of the entire series, composed of ten important families, occupies only thirty pages.

The account of the Diptera is very satisfactory as a whole. The Culicidæ, owing to recent discoveries as to the importance of this group, naturally receiving a somewhat extended notice, accompanied by an excellent schematic figure illustrating the life cycle of the malarial parasite. As in some other groups, the author gives a list of the species known to occur in India, following Theobald in this particular instance. It is interesting to note that only two species of Cecidomyiidæ, probably less than one per cent. of the native fauna, are recorded from India. The chapter on Indian blood-sucking insects gives a comprehensive notice of the species addicted to this practise and their economic relations. A considerable number of Rhynchota (Hemiptera) are briefly noticed, though comparatively few Aphididæ and Coccidæ, two groups of great importance in temperate regions, are

discussed. Occasionally there appears to be a slight looseness in wording, as, for example, where the author states that members of the other orders are "deliberately mimicked" (p. 397). Presumably this is hardly what the author intends. We regret the absence of any note upon the value of birds as checks upon insect life. Members of this class rank as most important agents in controlling injurious insects in the temperate regions, and it would seem as though there should be some discussion of the relations existing between them and insect life, even in a work treating of tropical species. The book is completed by a table of contents and an index. We much prefer the general index to separate indices for plants and insects.

This volume with its large series of illustrations, most of them excellent and some surprisingly accurate, must prove of great service to Indian entomologists and of value to others desiring to make comparisons between faunæ of different regions. It is particularly serviceable to the economic entomologist, since the authors have given most of their attention to applied entomology, and many of the colored plates illustrate insect pests. They are to be congratulated upon having prepared a work which will do much to advance the knowledge of Indian entomology.

E. P. FELT

The Fauna of British India. Dermaptera. By MALCOLM BURR, D.Sc., M.A., F.E.S., F.L.S., F.Z.S. Published under the authority of the Secretary of State for India in Council. London, Taylor & Francis. 1910. 8vo, pp. xviii + 217. One colored and nine plain plates. Numerous figures in the text.

The last volume of "The Fauna of British India" to appear from the press is the monographic work upon the Dermaptera of India, Ceylon, and Burma, from the pen of Dr. Malcolm Burr. It is the first volume of the series which has been published under the supervision of Dr. A. E. Shipley, who upon the death of Lieutenant-Colonel C. T. Bingham, the successor of Dr. Blandford, assumed the editorship of this important series of publications.

The Dermaptera, or earwigs, form a compact and well-defined group of insects, which originally were included by Linnæus among the Coleoptera, by De Geer were raised to the rank of an order, and by many later writers have been treated as a family of the Orthoptera. Dr. Burr treats them as a distinct order, and rejecting the amendments of the name suggested by Agassiz and Burmeister, and the half a dozen substitutes proposed by other writers, employs the name originally applied to the group by De Geer and sanctioned by extensive use.

The species of Dermaptera found in the more temperate regions of the world are not numerous, only two occurring in Great Britain, but in the tropics they are much more abundant, and in the volume before us the author enumerates over one hundred and thirty species.

Comparatively very little has hitherto been written upon this interesting order and the bulk of Dr. Burr's work is, as is pointed out by Dr. Shipley, the result of original investigation.

After a brief preface the author gives us a Systematic List of Species. These fall into five families, containing in all fifty-one genera. There are one hundred and thirty-three species definitely allocated and two *incertæ sedis*. The three largest genera are *Diplatys* Serville, *Forficula* Linnæus and *Labia* Leach, containing, respectively, twelve, eleven and eight species. Many of the genera contain but a single species in the faunal region covered by the work.

The next section of the work is styled the introduction, and presents a full and very satisfactory account of the structure, development, habits, and geographical distribution of the Dermaptera. The bulk of the volume is devoted to a detailed description of the various families, subfamilies, genera, and species. There are three appendices, one giving directions for collecting and preserving Dermaptera, the second containing a list of the authors cited, and the third furnishing a glossary

of terms employed. The plates appear to be carefully drawn and are artistically excellent. A careful examination of the book leaves a delightful impression upon the mind. It is in many respects a model of monographic treatment, and the editor, Dr. A. E. Shipley, is quite right in saying that whereas

> Dr. David Sharp in the Fifth Volume of the "Cambridge Natural History" states: "The classification of the earwigs is still in a rudimentary state." . . . Burr's work will cause the deletion of this sentence if a new edition of Dr. Sharp's volume be called for.

The author of the work intimates that he is engaged in preparing upon the same lines an account of the Dermaptera of the entire world. The appearance of such a work will certainly be welcomed, and the present reviewer hopes that the learned author may be spared in health to complete it at no distant day.

W. J. HOLLAND

CARNEGIE MUSEUM,
March 15, 1910

SPECIAL ARTICLES

CANAL-RAY EFFECTS IN OPEN AIR DISCHARGE

IN a paper recently published[1] the writer has shown that the positive luminescence in a Geissler tube is due to a progressive ionization of the air column, and that this ionization begins at the anode wire. In a long tube like that used by J. J. Thomson, this ionization may extend over a distance of fifteen meters.

Since the publication of the paper, evidence has been secured on photographic plates, showing that a disruptive spark discharge in open air can not be produced, until such ionization, originating at the anode terminal, has reached the negative terminal.

Confirmation of this conclusion may be obtained in the manner now to be described. We have used a large eight-plate influence machine.

Small spark-knobs are so adjusted that a torrent of loud sparks passes between them. Hang midway between the knobs a sheet of copper. It is suspended on long silk threads, its plane being at right angles to the line joining the knobs. The sparks can not now be made to pass. A column of positive luminescence joins a positive terminal and a copper plate, but the cathode half of the gap is dark. A glass rod interposed in the positive luminescence casts a shadow on the side turned away from the anode. The shadow is not bounded by right lines, as is the case in rarefied air, where the mean free path is great. When the rod is held near the copper plate, a shadow is, however, cast on the plate. If the plate is moved to a parallel position near the negative terminal, a torrent of sparks passes through the plate. If moved in the opposite direction, until it makes contact with the positive knob, no sparks will pass in any position of the plate. A negative inflow to the edges and corners of the plate is now taking place, as is shown by brush "discharges," but the ionization effects are dispersed in such a way that the conducting channel or channels through the air do not lead to the negative terminal, and no spark can pass unless the spark gap is made shorter.

We have here a clear explanation of the reason why the spark length is greater, when the positive terminal is a small knob than when it is a large one.

A small windmill was placed in the positive luminescence, with its plane of rotation at right angles to the discharge. The vanes were of thin mica sheet. The diameter from tip to tip of the vanes was 8 cm. The vanes were mounted on a hub of hard rubber having a shaft of vulcanized fiber, and turning on pivots of fiber or glass, mounted in hard rubber. The vanes rotated in a direction which showed that the air was drifting away from the positive terminal. As nearly as could be estimated, the rotation was such as was produced by carrying the mill through still air with a velocity of 1.5 meters per second.

All of the results described are produced when the negative terminal is grounded.

These phenomena show that in all probability an X-ray tube will be much less likely to suffer puncture, if its cathode is grounded.

[1] *Trans. Acad. of Sc. of St. Louis*, Vol. XIX., No. 1.

In that case the cathode discharge is (to use a figure of speech) drawn through, rather than forced through the tube. Their bearing on lightning protection may also be of importance.

FRANCIS E. NIPHER

A PRELIMINARY REPORT OF A NEW BLOOD PICTURE

THE fact that the white blood cells and particularly the neutrophiles of the blood react to certain bacilli and certain toxins in such a definite way is of great assistance to the differential blood count either in diagnosis or in prognosis.

Arneth[1] first showed something of this in his papers upon tuberculosis where he showed that while blood of a normal person contains neutrophiles which have nuclei from one to five lobes, that of a tubercular person contains neutrophiles whose nuclei have only one, two or three lobes.

A study of the neutrophiles of normal blood shows that they can be divided into five groups according to the number of the lobes of the nucleus, *i. e.*, Group I., those neutrophiles which contain a single lobed nucleus; Group II., those which contain two lobes and so on up to Group V., which contains those neutrophiles which have five lobes to the nucleus. The number of neutrophiles in these different groups, where one hundred neutrophiles have been counted, forms what may be called the differential neutrophile count, and this is practically constant for all normal blood.

	I.	II.	III.	IV.	V.
100 neutrophiles	5	20	48	22	5

To make this as simple as possible, in order to chart it, a proportion between the two types of neutrophiles can be made as was suggested by Bushnell and Treuholtz,[2] that is, between those neutrophiles which have the fewer lobes, or Group I., Group II. and half of Group III. and those neutrophiles which have more lobes, or Group V., Group IV. and half of Group III.

[1] Arneth, "Die Lungenschwindsucht am Konig Juliuspital," Wurzburg, 1905.

[2] C. E. Bushnell and C. A. Treuholtz, *Medical Record*, March 21, 1908.

Since in normal blood the proportion is usually even, one can thus see at a glance to which side the number of pieces of the nucleus has shifted.

	I.	II.	III.	IV.	V.
Blood from normal person	5	20	48	22	5 = 49:51
Blood from person with tuberculosis	20	32	40	8	0 = 72:28
Blood from person with infection ..	2	8	40	30	20 = 30:70

The results from my experiments seem to prove that the neutrophile reacts to changes in its environment by some change, probably metabolic, which involves the nucleus and that the state of the nucleus, together with the differential blood count, can be used as a guide as to the condition of the body.

Experiments where guinea pigs were inoculated with tuberculosis bacilli show that the neutrophile first reacts by a rapid increase in the number of lobes of its nucleus and then, later when the guinea pig reaches a state of definite tuberculosis, the neutrophile contains a nucleus of but one, two or three lobes.

Experiments of different sorts show that this same increase of the number of lobes of the nucleus can take place in blood outside the body in such a short time as five or ten minutes.

All the slides I have examined in the opsonic work show this same increase in the number of lobes of the nucleus and I might mention here that it seems a mistake to test certain serum with normal neutrophiles as is done in Wright's opsonic work, since the neutrophiles of the patient may have an entirely different ability to react, from those of the normal person.

Some toxins, especially snake toxin, has the same effect upon the neutrophiles and causes a great increase in the number of lobes of the nucleus.

Observations in the hospital, together with these experiments, seem to prove that the neutrophiles first react to the presence of bacilli or a toxin by some metabolic change, which is shown by increase in the number of lobes of the nucleus; these reacted cells then break down or are used up in the blood followed by

a leucocytosis, which brings in the younger neutrophiles, *i. e.*, with one or two lobes, from the bone marrow. If there is enough toxin or bacilli present, these neutrophiles react even with a leucocytosis and, in all such cases, pus has been shown to be present. As the infection disappears, the neutrophiles cease to react and the number of white blood cells drops until the blood picture is again normal. A good prognosis in such an infection as pneumonia would be a high white blood cell count together with a large proportion of the neutrophiles having the smaller number of lobes to the nucleus, for in this case the neutrophiles which react are being used up and new ones brought into the blood to take their place.

The following are a few typical blood pictures:

Normal

Differential Blood Count		Differential Neutrophile Count	
W. B. C.	8,000	I. 5	
Neutrophiles	65	II. 22	
Large lymphocytes ..	23	III. 48	48:52
Small lymphocytes ..	12	IV. 26	
Eosinophiles	0	V. 5	
Basophiles	0		

Tuberculosis

W. B. C.	10,000	I. 20	
Neutrophiles	64	II. 40	75:25
Large lymphocytes ..	28		
Small lymphocytes ..	6	III. 30	
Eosinophiles	1	IV. 10	
Basophiles	1	V.	

Pneumonia

W. B. C.	20,000	I. 30	
Neutrophiles	80	II. 40	80:20
Large lymphocytes ..	15		
Small lymphocytes ..	5	III. 20	
Eosinophiles	0	IV. 10	
Basophiles	0	V.	

Pus Case

W. B. C.	24,000	I. 4	
Neutrophiles	80	II. 14	
Large lymphocytes ..	12	III. 18	
		IV. 32	27:73
Small lymphocytes ..	6	V. 21	
Eosinophiles	1	VI. 9	
Basophiles	1	VII. 2	

The differential blood count is necessary to determine the different kinds of blood cells present in the blood, but the state of the neutrophile is also of great assistance in making the diagnosis and especially the prognosis.

A paper which gives in detail these experiments, which were carried on in the laboratory of Dr. Max Hartmann, in Berlin, will appear shortly; also the hospital observations made in connection with Dr. James Alexander Miller at the Bellevue Hospital will be reported in a paper with Dr. Miller in May.

MARGARET A. REED

NOTES ON THE FOOD OF A KING EIDER

A FEMALE king eider (*Somateria spectabilis*) was captured on Seneca River, N. Y., November 26, 1909, by Mr. J. T. Lloyd. After preserving the bird for the Cornell University Museum (No. 5332), the enteron was opened and examined for its food contents. In view of the scarcity of accurate notes dealing with the food of our wild ducks, the material examined would seem to justify the presentation of the data which follow:

CONTENTS OF THE CROP AND STOMACH

Pisces—1 specimen *Boleosoma nigrum olmstedi*, johnny darter.
Amphibia—2 specimens *Rana pipiens*, leopard frog.
Insecta—3 specimens *Gyrinus*, whirligig-beetle.
Crustacea—67 specimens *Gammarus fasciatus*, fresh-water "shrimp."
Mollusca—1 specimen *Planorbis*, small, 2 mm. in diameter.

CONTENTS OF THE GIZZARD

Amphibia—Bones of at least one frog.
Insecta—2 specimens, *Gyrinus*.
2 specimens, *Corisa*, water-boatman.
Crustacea—5 specimens, *Gammarus fasciatus*.
1 specimen, *Asellus*.
Mollusca—3 specimens, *Physa*.
1 specimen, *Limnæa*, small.
1 specimen, *Planorbis*, small, 1 mm. in diameter.
Several pieces of the shell of some large bivalve.
Vegetable—2 small seeds not identifiable.
3 small pieces of the leaves of some aquatic plant.

Mineral matter to the extent of about a dozen grains of sand.

The food in the stomach and crop was very well preserved and it was possible to identify with certainty some of the animals to species —a condition which also obtained rather unexpectedly for a portion of the food in the gizzard, particularly the fresh-water "shrimps." The question arises: How many of these animals were deliberately pursued by the duck? As far as the vertebrates are concerned, there is no doubt but that they were voluntarily taken. The presence of only a small amount of vegetable matter favors a like assumption for all of the invertebrates mentioned, forms which at this time of year occur almost exclusively in the aquatic vegetation. If they were accidentally taken, it would necessarily have been incidental to a large amount of vegetable material.

The beetles and water-boatmen are erratic and rather rapid swimmers and in all probability would have escaped unless deliberately chased by the duck. The disagreeable acrid odor given off by the former evidently did not protect them to any great degree from the bird.

In all of the unbroken molluscan shells the soft parts of the animals were preserved, indicating that the animals were picked off from the vegetation alive.

The surprisingly large number of freshwater "shrimps," in view of their great ability to conceal themselves under shelter of almost any sort, shows without a doubt that they were voluntarily taken; it also gives a further indication of the importance of this group of crustacea in the economy of water-loving vertebrates.

If our assumption is correct that all of these swiftly moving and self-concealing animals were taken voluntarily, we have an example of a keenness of vision capable of discriminating between food and other substances to a degree not usually ascribed to the flat-billed ducks.

G. C. EMBODY

CORNELL UNIVERSITY

A LARGE SPERM WHALE CAPTURED IN TEXAS WATERS[1]

THE capture on our coasts of a whale of any species is a rare occurrence and worthy of note. The present instance therefore seems to me to deserve some especial attention.

On March 10 of the present year I received a telegram from Port Arthur, Texas, informing me of the capture of a huge sperm whale near Sabine, a small town on the gulf, and offering me every opportunity for making a scientific examination of the prize.

The following day I went down to Port Arthur and found that the animal had suffocated in the mud shallows and had been towed ashore. On my arrival the carcass was on exhibition on a board platform back of one of the docks. Owing to the heat, decomposition had already set in and hence no opportunity was afforded of securing histological material. I availed myself, however, of the opportunity of taking a careful series of measurements, which I here put on record. This seems worth while, since there are few, if any, authentic measurements of large whales to be found in the literature.

	Ft.	In
Total length (air line from tip of snout to extremity of tail flanges)	63	6
Circumference in front of pectoral fins	37	
Width across tail flanges	16	7
Tip of snout to base of pectoral fin	24	6
Tip of snout to angle of mouth	17	1
Dorso-ventral diameter of flat end of snout	10	4
Tip of lower jaw to angle of mouth	10	10

There were 48 teeth in the lower jaw, each of which fitted into a fleshy depression of the upper jaw, which was toothless except for the occasional presence of very small rudimentary tooth-like structures in the bottoms of these depressions.

On the night of March 12 the animal was eviscerated, with the aid of a gang of about twenty negroes and a steam winch, and the abdominal cavity filled with ice. This was dissection on a large scale and afforded a

[1] Contribution from the Zoological Laboratories, University of Texas, No. 104.

unique experience. Nothing of especial note, however, was brought to light.

The whale was evidently an aged "bull" that had been driven from the "herd" by the younger males, had led a "maverick" existence for some time and had strayed far from his native haunts. It is probable that he had met his fate through an ill-advised pursuit of a school of cuttle-fish or squids into a shallow bay, where he became stranded in soft black mud, which soon filled his lungs and literally drowned him.

I have been able to find no previous record of a sperm whale coming ashore on the Gulf of Mexico. If there are other cases I should be glad to learn of them.

H. H. Newman

Austin, Texas

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SECTION G—BOTANY, BOSTON MEETING

As in previous years, Section G held its sessions in alternation with the Botanical Society of America. At Boston a further system of interlocking was made necessary by the program of the newly organized American Phytopathological Society, but it was found by making mutual concessions that conflict of programs could be reduced to a minimum. One joint session was held with the American Phytopathological Society. In the enforced absence of Vice-president Penhallow on account of illness, Dr. B. M. Davis, of Cambridge, was selected vice-president pro tem. The address of the retiring vice-president, Professor H. M. Richards, entitled "On the Nature of Response to Chemical Stimulation," has been published in full in Science. This address was followed by a symposium on botanical gardens, participated in by William Trelease, N. L. Britton, W. F. Ganong, D. S. Johnson and A. F. Blakeslee; it is expected that this symposium will be published in full in Science.

The following officers were chosen:

Vice-president—Professor R. A. Harper.

Member of the Council—Professor A. D. Selby.

Member of the Sectional Committee (five years)—Professor H. M. Richards.

Member of the General Committee—Professor G. F. Atkinson.

Abstracts of the technical papers follow.

Further Observations on the Nature of the Fertile Spike in Ophioglossaceæ: M. A. Chrysler.

The writer's view as to the morphological nature of the fertile spike in Ophioglossaceæ, derived from an anatomical study, receives striking confirmation from certain specimens of *Botrychium obliquum* collected in New Hampshire. These bear either a pair of fertile spikes in place of the normal one, or a pair in addition to the normal one and inserted above it. The vascular supply of the pair of spikes indicates that they represent a pair of fertile leaflets, and the single spike represents a fused basal pair of fertile leaflets. In some cases the two spikes of the pair are fused for part of their length, and in other cases part of the ordinarily sterile segment is fertile. These facts in connection with other considerations lead to the conclusion that the fertile spike of *Botrychium* and *Ophioglossum* represents two fused basal pinnæ of a fern leaf.

Change of Sex in Humulus Lupulus not due to Traumatism: W. W. Stockberger.

The bisexual inflorescence of *Humulus Lupulus* L. was the subject of a brief paper read by the writer before the Botanical Society of America at the Chicago meeting in 1907–8. Since that time some experiments have been performed and data from other sources collected which tend to refute the theory that traumatism is the cause of this abnormality. Removal of the tap root, severe pruning, removal of portions of the crown and cutting back the vines after they had attained a length of four to six feet all failed to cause any change in the normal production of the flowers.

Further, the experiments show that a plant which once produces the abnormal type of inflorescence will continue to do so through successive seasons and will transmit this tendency to its asexual progeny. So far as observation goes, it appears that only plants bearing pistillate flowers are subject to reversal of sex. In an experimental plot of 1,400 seedlings all the plants were apparently normal at first and bore either staminate or pistillate flowers respectively. Later in the summer some of the plants bearing pistillate flowers developed staminate flowers also. Since none of these plants were subjected to the vigorous traumatic treatment described above it is held that some factor other than traumatism produces the sex reversal.

The Taxonomic Value of the Cephalodia in Certain Species of Stereocaulon: Lincoln W. Riddle.

Stereocaulon paschale (L.) Ach. and *S. tomentosum* Fr. have been separated hitherto chiefly by

the amount of tomentum present on the podetia. This, being a variable character, has led to much confusion. It is suggested that the types of cephalodia, being mutually exclusive, may furnish a basis for distinguishing the species. *Stereocaulon paschale* has conspicuous, gray cephalodia containing *Stigonema;* while in *S. tomentosum* they are minute, deep green and with an alga of the *Nostoc* type. In only one case, out of 103 specimens studied, were both types found on the same plant. A statistical study based on the development of tomentum, the position of the apothecia and the type of cephalodia shows that cephalodia are present in about 90 per cent. of the specimens, being more constant in their occurrence than apothecia, and that they are correlated with the development of tomentum to a sufficient degree to warrant their use as a criterion for separating the two species of *Stereocaulon* named. It may be added that *S. alpinum* Laur. has the same type of cephalodia as *S. tomentosum;* while *S. coralloides* Fr. and *S. denudatum* Flke. have the *paschale* type.

Cell and Nuclear Division in Closterium: B. F. LUTMAN.

Closterium, like many of the algæ, is only found in division at night from 10 P.M. to 4 A.M.

The first external sign of division is a pinching in of the chromatophore about two thirds of the way from either tip. No external change is visible in the nucleus at this time. Later, the nucleus apparently disappears and across the middle of the *Closterium*, in the place formerly occupied by it, appears a broad granular band. The cell wall now begins to grow in across the center of this band separating the two halves. In stained whole mounts the two nuclei resulting from division can now be seen making their way back immediately under the plasma membrane to the point where the chromatophore is being pinched in two, in either half. The two halves now break apart, and the new ends are rounded out at first, but rapidly grow and become pointed, making the two halves of the new *Closterium* symmetrical. The entire process takes about four to six hours, as few asymmetrical ones are found at 8 A.M.

The chromosomes are formed from a spireme whose origin is in the fine reticulum around the compound nucleole. There are about thirty to forty of them, slender rods. They arrange themselves on the equatorial plate of a spindle with broad poles, similar to that described for *Spirogyra*. In the reconstruction stages they seem to unite end to end to form a dispireme. They spin out and become fainter and the compound nucleole reappears. There is no evidence that the chromosomes have their origin from the nucleole. The two nuclei move away from each other around the chromatophore, between its ridges, to take their place at the middle of the new halves.

Cell division is by the growth inward of kinoplasmic material which lays down the new wall. The wall cuts across the cell at right angles to the side walls. The central spindle fibers disappear and have nothing to do with its construction.

Corallorhiza and Mycosymbiosis: BENJ. C. GRUENBERG.

Several species of *Corallorhiza* store starch in the rhizome; this is secondary starch, that is, it is derived from organic materials in the soil or humus and is not the direct result of photosynthesis on the part of the plant. Stomata are present in all parts of the epidermis; these are probably active and must be concerned with gas exchanges involved in respiration. The trichomes and epidermis of the rhizome serve for absorption of materials from the soil. It is not necessary to assume that any species of *Corallorhiza* is dependent upon its fungal symbiont for its nutrition. The symbiosis is indeed a constant character of the species examined, but it probably results from the habit of the fungus; it is at any rate not necessary to assume that it is obligatory for the maintenance of the orchid. The fungus may be of assistance to the orchid by furnishing conditions favorable to the germination of the latter's seeds; but it is not improbable that other conditions may also stimulate the seeds to germinate. It is not certain that the fungus is indispensable to the orchid in this connection. The permanent association does not seem necessary for the germination since there are no hyphal connections between the rhizome and the inflorescence. The infection of the rhizome takes place about the time of germination. Hyphæ traversing the trichomes are on their way out; these connections may serve the fungus as means of propagation, but need not be assumed to be of use to the orchid in nutrition. The "digestion" of hyphal masses within the cortical cells may be considered as a means for preventing the spread of the fungus to the point of injuring the orchid; it need not be assumed to be necessary for the nutrition of the orchid. The fungus is probably an internal saprophyte. The mycosymbiosis may have different significance in other families of plants. There is in preparation a "host" index and bibliography of all mycorhizas that have been described.

The Origin of the Primary Bulb in Erythronium: Frederick H. Blodgett.

In the mature seed the embryo of *Erythronium* is a globose mass of cells, without differentiation, slightly pointed toward the micropyle. The seed remains dormant during the summer. The embryo begins to elongate with the coming of the late summer rains. The tip of the cotyledon is early organized as a haustorium, and absorbs the reserve cellulose along the line of elongation. When the embryo has elongated to half the length of the seed the stem apex may be recognized.

The stem apex is located in a narrow transverse slit situated just behind the radicle. By the growth of the cotyledon above the slit, the radicle and the stem apex are forced into the soil. The hypocotyl takes no part in the descent of the stem apex. With the exhaustion of the reserve food of the seed the descent of the stem apex stops. The primary root pushes forward from the end of the descending axis, while the cotyledon frees its tip from the seed coats and reaches upward into the air. One root only is formed by the seedling, and this is unbranched, in our species.

A dropper (primary runner) is formed from the walls of the slit and cells immediately adjacent, and carries the stem apex (primary growing point) forward from the base of the descending axis as the terminal bud in the dropper. The walls of the dropper are equivalent to the first scale leaf of the primary growing point, fused along one side to the stalk of the bud through which vascular connection is maintained with the cotyledon and primary root. The relation of parts is similar to that of the raphe to the rest of the ovule in anatropous ovules.

The primary growing point within the dropper sheath organizes a second scale leaf, the first scale being the dropper sheath.

The second scale leaf encloses the growing point, and these form the bulk of the primary bulb; the sheath of the dropper forms the husk about the bulb. The starch for storage in the growing bulb is obtained through the photosynthetic activity of the cotyledon, acting as the first foliage leaf. The death of the other parts of the seedling leaves the terminal bud of the dropper isolated in the soil as the primary bulb, and marks the end of the first vegetative period of the cycle from seed to flower.

Some New Hybrids and their Bearing on the Classification of Wheat: B. C. Buffum.

The classification of wheat has gone through several changes since the first division by Linnæus into fall and spring species. Hackel recognizes three true species and two subspecies of *Triticum.*

Should some botanists of the present apply their ideas of specific characters to cultivated plants we should have many species of wheat. It is doubtful if any term used in science means less to the thoughtful student than the word species.

My recent work with wheat shows that we may accept the species of Hackel from the old standpoint of their action in cross pollination and yet all have the same origin.

From a single hybridization between a mutating *Triticum sativum* (winter wheat) and a mutating *Triticum dicoccum* (winter emmer), I have secured a complete breaking up of wheats into all the species and types since the beginning of time, and in addition produced infertile hybrids, monstrosities and new types not intermediates. The second generation has given well-defined specimens of *Triticum monococcum, T. dicoccum, T. spelta, T. polonicum* and almost if not quite every well-marked type of *T. sativum,* including various colored bearded and beardless, square head, club and long-headed forms, with every arrangement and shape of glumes and spikelets.

The evidence is conclusive that all wheats have developed from not more than two and probably from a single form.

The question arises should we accept one species or are we justified in using every variation as a specific difference which would divide wheats into many species, and if so, where may the line be drawn?

The Closing Response of Dionæa muscipula Ellis*:* W. H. Brown and L. W. Sharp.

The closing response of *Dionæa* depends upon the intensity rather than upon the number of stimuli, the number of stimuli required varying in the inverse order of their intensity.

Response is normally brought about by the compression of certain cells at the bases of the sensitive hairs, but the compression of other cells of the blade also causes closure, and it is probable that the latter cells are equally sensitive with those at the bases of the hairs, as is indicated by the effect of electrical and thermal stimulation.

The closing response follows the application of mechanical, electrical or thermal stimulation. It also follows a combination of stimuli of two kinds when consecutively applied, the individual stimuli being of an intensity such that either alone would be insufficient.

The effect of mechanical stimulation is due to a compression of cells, and not to contact with a

hard object, nor to continued pressure, nor to release of pressure. The failure of the leaf to respond to shaking is probably connected with the small inertia of the sensitive hairs, and the slight resistance offered by the air to their passage through it.

Water at room temperature causes closure only when it bends a sensitive hair.

After one mechanical stimulus there is a short period during which a second mechanical stimulus is ineffective.

Effects of Acidity of Culture Media upon Morphology in Species of Penicillium: CHARLES THOM.

Increasing recognition of the economic importance of saprophytic forms, such as species of *Penicillium*, lends interest to the study of their metabolic activities. Although production of certain enzyms determines the ability to digest particular forms of food, the elements necessary to normal growth of any of these forms are present in nearly all kinds of fruit, meat and vegetables, or other food products. The presence or absence of a particular species of *Penicillium* as an agent of fermentation or decay, is therefore determined by its tolerance of other factors. Among these are temperature, relative humidity of the atmosphere, percentage of water in the substrata, the forms of carbohydrate present, the concentration of osmotic substances, and the alkalinity or acidity of the media. One of the easiest of these to demonstrate relates to the alkalinity or acidity of the medium. The cultures shown represent a series of conditions illustrating the range of this tolerance for certain species of *Penicillium*.

Using tubes containing 10 c.c. each of a medium neutral to phenolphthalein, alkali has been added as normal sodium hydroxid, and acid as normal lactic acid. The change in the constitution of the medium can thus be given as cubic centimeters of normal acid or alkali per ten of medium. Uniform volume is maintained by increased concentrations. The range of tolerance in the species studied is from 2 c.c. of alkali per 10 c.c. of medium to 5 c.c. of normal acid to the same amount of medium. Within this extreme range, most species are much more closely restricted. Very few species grow to any degree in plates alkaline to phenolphthalein (*P. brevicaule* and its allies). Of the very common green species but few fruited freely in alkali as strong as a tenth normal. Nearly all grow best between the neutral point and an acidity approximately equal to tenth normal. The most widely reported forms show naturally the greatest tolerance (*P. roqueforti*, *P. expansum*).

The inhibiting effects of acid vary with the species and with the kind of acids. The first effect noted is usually the retardation of growth and especially of the production of colored spores. In some the retardation is temporary; again it reduces the final size of the colony. There results a gradation from the normal colony to very small colonies but with typical morphology. In others, a concentration is soon reached which inhibits the production of colored spores entirely. In others the production of bright colors in the substratum is partly or entirely stopped. The typical morphology of fruiting areas is often greatly changed.

Testing their tolerance to acid emphasizes the close relationship of certain groups of forms and offers a very useful accessory to the description of species. Along with other cultural evidence it seems to show that the presence of special forms as agents of decay in certain fruits (*P. italicum* and *P. digitatum* on citrus fruits), is due not so much to adaptation to the fruit as a form of food as to tolerance of the other substances present. It should be noted that in synthetic media it can be readily shown that the standard formulæ (Raulin's, Cohn's, Uschinsky's, Czapek's) are extremely dilute and in no sense to be regarded as the optimum for mold growth. In fact in solutions of non-toxic substances much greater concentrations may be used than any of these formulæ call for and bring about correspondingly greater masses of typical mold growth. The responses to acidity are much more rapid and radical in the character of the growth obtained, hence quickly reach a diagnostic value in most species.

Effect of Various Gases and Vapors upon Etiolated Seedlings of the Sweet Pea: LEE I. KNIGHT, R. CATLIN ROSE and WILLIAM CROCKER.

The effects of impurities of laboratory air upon the etiolated epicotyls of seedlings of various legumes have been described by a number of German investigators. The effects are three: decrease of rate of growth in length, swelling of the region growing while exposed to the impurity and a horizontal placing of region. These investigators assume that almost any gaseous impurity, even in low concentration, will produce this three-fold response. The accompanying table shows determinations made with eleven gaseous impurities upon the sweet pea, Earl Cromer. The horizontal placement induced by ethylene, illuminating gas and acetylene seems to be an induced diageotropism.

Gas Used.	No. of Parts per Million of Atmospheres to Cause Considerable—		
	Inhibition of Growth.	Swelling.	Horizontal Placing.
Ethylene	.1	.2	.4
Illuminating gas	2.5	5	10
Acetylene	100	250	500
Hydrogen sulfid	500		
Sulfur dioxid	1000		
Carbon disulfid	2000		
Turpentine	2500	5000	
Benzene	4000	8000	
Ethyl ether	10000	40000	
Chloroform	10000	20000	
Benzine	24000	20000	

A New Method of Detecting Traces of Illuminating Gas: LEE I. KNIGHT, R. CATLIN ROSE and WILLIAM CROCKER.

It has been shown that 12.5 parts of illuminating gas or .5 part of ethylene per million of air will play havoc with flowers of the carnation. Chemical tests will detect no less than 100 parts of illuminating gas per million of air. In a number of cases known to us greenhouse men have been unable to determine, through lack of a delicate test, whether illuminating gas was the cause of serious injuries to their crop. In these cases there was much evidence that gas leaking from imperfect pipes, seeping through the ground up into greenhouses was the cause of the injury. The injuries occurred in cold weather when the ground was frozen and the houses could be little aerated and they ceased with the repair or removal of the defective pipes. We believe from our results reported in the paper above that the etiolated epicotyl of the sweet pea will furnish a delicate and accurate test for traces of illuminating gas.

The Stele of Osmunda cinnamomea: J. H. FAULL.

Nodal rays occur in the xylem of seedlings of *Osmunda cinnamomea*, and eventually the edges of one of them close around the intruding parenchyma to form a "stelar" pith. The "extrastelar" pith arises as an eccentric pocket at the inner entrance to a leaf-gap. Its connection with the cortex has been observed in the adult only. Branching is not a seedling character. The seedling stage is long drawn out, and variable. Internal phloem has been found in abnormal unbranched plants.

There is a marked tendency in the Osmundaceæ for the xylem to encroach on the pith. Thus in *Osmunda cinnamomea* one finds internal strands of xylem, closure of the inner ends of medullary rays (in reduced plants to the extent of simulating the cladosiphony of *Osmundites Dunlopi*, etc.), parenchyma pockets in the xylem (characteristic of the family), projections of the internal endodermis in these pockets, etc., all of which indicate a tendency towards "cladosiphony" in the Osmundaceæ, and a possible point of contact with the Gleicheniaceæ.

The facts connected with the stele of *O. cinnamomea* are held to support the theory of the reduction of the osmundaceous stele from an amphiphloic siphonostele.

The Ontogeny of Helvella elastica: W. A. McCUBBIN.

The fruiting body arises from aggregated masses of the mycelium. It is enclosed at first by a definite velum which early degenerates. Throughout life a layer of club-shaped palisade hyphæ covers the whole surface. Scattered throughout all parts of the interior except in the stem, are large irregular cells serving apparently as storage organs.

The ascogenous hyphæ are differentiated from ordinary hyphal filaments and form a subhymenial layer. These ascogenous hyphæ produce lateral branches from whose 2-nucleate, terminal cells the usual 4-nucleate hooks are formed.

The process from the antepenultimate cell of this hook may, without fusion of its two nuclei, form a second and similar hook, and this series may extend to at least a sixth, the process from the last, after nuclear fusion, becoming the ascus. Thus the two nuclei uniting to form the primary ascus nucleus are separately descended from the two in the terminal cell of the ascogenous hypha.

In any hook of a series the terminal and antepenultimate cells may fuse, their nuclei passing into a process arising from the terminal cell. This process is equivalent to that arising from the penultimate cell and becomes likewise either an ascus or another hook.

An Unusual Walnut: IRA D. CARDIFF.

Two instances of peculiar walnuts have come to the attention of the author: one from a tree of northern Indiana and the other from a tree of southern Tennessee. The trees were found to be walnut (*Juglans nigra*) in essentially all but their nut characters. The nut itself, externally at least, is very different in appearance from a walnut. The basal portion resembles very closely a walnut while the apical portion resembles a hickory nut, showing the four furrows that divide the external shell into its four valves. These furrows, however, do not extend entirely through the

endocarp. Laymen have assumed that these nuts are hybrids between the walnut and hickory, *i. e.*, the trees bearing them were true walnuts while the pollen involved in fertilization was from neighboring hickories. In face of known morphological facts this is impossible. The author expects to make a study of this matter from all view points. The purpose of this preliminary statement is chiefly to call attention to these plants and request any one having information of similar ones to kindly report to him at Washburn College, Topeka, Kans.

Studies upon Oxidases: H. Hasselbring and C. L. Alsberg.

The study is a by-product of the investigations still in progress of a disease of cabbages and spinach resembling in some respects the mosaic disease of tobacco. As in the latter there seems to be an increase in the oxidizing power of the juice of the diseased areas. By Woods this phenomenon was referred to an increase in oxidase content. To the authors this did not appear to be the only explanation conceivable. It was possible that the oxidase content was only apparently increased, the seeming increase being in reality due to a decrease of anti-oxidase. The anti-oxidases were therefore studied. It was found that egg albumen and blood serum inhibit these plant oxidases and that this inhibition can be prevented if the albumen or serum is first treated with weak acid. It was further found that the addition of coagulable protein to a plant extract varies greatly the ease with which the oxidase is destroyed by heat, probably because of the inclusion of the enzym in the clot. This may account for the fact that plant oxidases are less readily destroyed by heat than animal oxidases, for plant extracts contain as a rule less coagulable protein than those from animal tissues. These observations led to an investigation of oxidase zymogen. Woods made the very remarkable discovery that a plant extract which has lost its oxidizing power as the result of boiling may recover that power on standing some hours. Woods thought that the enzym was destroyed but the more resistent zymogen remained forming fresh enzym subsequently. We found that if a heated extract be centrifugated right after heating, and the clear liquid pipetted off from the coagulum, the clear liquid did not acquire any oxidizing power on standing, while that portion of the liquid containing the coagulum did recover its oxidizing power. It is possible, therefore, that we have to deal not with a zymogen but with the inclusion of the enzym in the clot and its subsequent leaching out on standing.

Some Teratological Features of the Coniferæ: Robert Boyd Thomson.

A new classification of the conifers, the outcome of recent research, has been suggested by the writer. In this the Taxaceæ and the Araucarineæ are associated, the group being characterized by a simple megasporophyll. The Abietineæ, Taxodineæ and Cupressineæ constitute the second group. These exhibit complexity in the structure of the seminiferous scale. Teratological features so far reported are practically confined to the latter, the diplosporophyllous group. These include androgyny, prolification or percrescence of the axis, and modification of the seminiferous scale, the latter often being replaced by a leafy shoot. By many the last of these features, especially, is considered as affording evidence of the brachyblast character of the ovuliferous scale. The writer's observations on numerous hermaphrodite cones of *Pseudotsuga mucronata* confirms and extends this conception. In the aplosporophyllous series, on the other hand, certain teratological features have been found that afford confirmation of the simplicity of the cone scale.

On the Distribution and Origin of Ray Tracheids in Pinus Strobus and P. resinosa: W. P. Thompson.

Ray tracheids are characteristic features of certain coniferous woods, notably the pines. A detailed study of their regional distribution in a soft and a hard pine (*P. Strobus* and *P. resinosa*) shows their virtual absence from such primitive places as the stem and root of the seedling, the young branch of the adult and the axis of the seed cone. Their shape and character on first appearance, their mode of development at the cambium, and certain peculiarities of their adult form, demonstrate that they originate from tracheids. These, in the course of specialization, become shortened, radially arranged and intimately associated with the parenchyma cells of the ray. Their extreme specialization is reached in the short buttressed cells of the hard pines.

The knowledge of their distribution and origin in the forms studied supplies a basis for a determination of their general phylogenetic significance.

The following papers were read by title:

On the Organization and Reconstruction of the Somatic Nuclei in Podophyllum peltatum: J. B. Overton.

Cleistogamy in the Genus Muhlenbergia: Agnes Chase.

The Chart Method in Taxonomy: Frederic E. Clements.

Evaporation in its Relation to the Prairie at Lake Okoboji, Iowa: B. Shimek.

Alpine Plants and Evaporation: Charles H. Shaw.

The following papers represent the contribution of Section G to the joint session with the American Phytopathological Society:

A Spinach Disease caused by Heterosporium variabile: Howard S. Reed.

Early in 1909 a serious leaf spot was found on spinach in the trucking region about Norfolk, Va. Investigation showed that it was due to *Heterosporium variabile*. This fungus seemed to occur only where other fungi had previously attacked the leaves, and thus confirms views of previous investigators concerning its weak parasitism. The fungus hyphæ when once within the cell spread through the protoplasm in a remarkable manner. The effect of the fungus on the anatomy of the leaf and the process of spore formation have also been studied. Inoculations with pure and mixed cultures confirm previous statements of the parasitism of the fungus.

A New Species of Endomyces: Charles E. Lewis.

The fungus which is described in this paper was discovered while the writer was engaged in a study of fungi associated with apple decay at the Maine Experiment Station. According to its manner of fruiting, this fungus should be classified in the genus *Endomyces* but it does not agree in its characters with any described species.

This fungus grows readily and fruits abundantly on a large number of culture media. The characters by which the fungus is classified have not been changed by growing it on different culture media. The spore sacs, or asci, each containing four spores, have been found in all the cultures, but some media have been found more favorable for their development than others.

The details of spore formation are difficult to make out owing to the small size of the asci and of the nuclei, but they have been studied to some extent.

Three Species of the Type of Æcidium cornutum Pers.: Frank D. Kern.

The name *Æcidium cornutum* has until recently been made to include practically all of the cornute *Rœstelia*. It is now known that in Europe two species have been here confused while in this country there have been three. The identity of these three species has now been worked out and their biology and morphology are discussed in this paper. The original *Æcidium cornutum* Pers. is found to occur only on species of *Sorbus*. The species which has been confused with this in both Europe and America occurs on species of *Aronia*. The third species, which is known only in America, grows on various species of *Amelanchier*. The knowledge of the life-histories of these three species will now permit many references in mycological literature to be straightened out.

Present Status of the Cotton Anthracnose Investigation at the South Carolina Experiment Station: H. W. Barre.

This paper includes the different phases of investigation as follows:

1. The vitality of the fungus under field conditions as shown by cultures and by germination of spores.

2. The method of infection of the seedlings.

3. The method of infection of the bolls as shown by (*a*) inoculation from pure cultures by puncture, (*b*) inoculation from pure cultures by spraying with spores from pure cultures suspended in sterile water (1) in bloom; (2) bolls in various stages of development.

4. The occurrence of the fungus on the inside of living seeds. (*a*) Method of entrance into the seed. (*b*) location in same; (*c*) production of spores beneath the seed coats; (*d*) development of diseased seedlings from such seed.

A Nectria Fruiting upon the Earth: J. B. Pollock.

The life history of the *Nectrias* is of considerable importance both from the point of view of pure science and of plant pathology. The *Nectria* in question was found developing on the surface of earth in which pine seedlings had dropped off with a fungus belonging to the form-genus *Fusarium*, presumably *Fusarium Pini*. It seems probable that the *Nectria* is the so-called perfect form of this species of *Fusarium*. However, this has not yet been proved.

Pine seeds were planted in pots and the soil inoculated with soil from an infected seed bed. Shortly after the seedlings came up they were attacked by a *Fusarium* which agreed essentially with *Fusarium Pini*. Some seedlings survived the attack and the pots were allowed to stand over more than two months in the greenhouse. At the end of that period small and very inconspicuous reddish bodies were observed scattered all over the surface of the soil in the pots. These were peri-

thecia of a *Nectria*. None of them grew upon the dead seedlings but directly on the soil. There was no stroma and no subiculum, though some hyphæ might be found radiating from the perithecia. The experiment was repeated, using infected soil and again the perithecia appeared in a little more than two months. The attempts to grow the ascospores were unsuccessful, perhaps chiefly because of the great numbers of bacteria which developed. Perithecia appeared upon two control pots out of fourteen, as well as upon all fourteen of the infected pots. The control pots stood beside the inoculated pots on the bench in the greenhouse. At the present time the connection between the *Nectria* and *Fusarium Pini* is not absolutely established, but seems very probable.

A Barley Disease: L. H. PAMMEL, CHARLOTTE M. KING and A. L. BAKKE.

During the past season a parasitic fungus made its appearance upon barley, during the early part of July. This new disease manifests itself in the form of brownish circular or somewhat elongated dark-colored spots. The leaves soon become brown. The long cylindrical dark brown spores have from seven to ten divisions and measure $105–130\mu \times 15–20\mu$. Cultures were made and inoculation experiments demonstrated that the fungus was parasitic upon barley but not upon corn. Hence the disease is different from the *Helminthosporium teres* found on corn and the *H. turcicum*. The spots of *H. graminum* consist of longitudinal striæ of yellowish green color; the spores of this species measure $75–95\mu \times 15–17\mu$.

Notes on some Diseases of Coniferous Nursery Stock: CARL HARTLEY.

Damping off of coniferous seedlings is commonly caused in this country by *Fusarium*, and favored by moist conditions. In a Nebraska nursery *Rhizoctonia* sp. and a fungus which appears to be *Pythium DeBaryanum*, have been found in diseased seedlings, and inoculations indicate the ability of both to kill germinating pine seeds and to cause damping off. A great deal of damping off occurred under very dry conditions. A parasitic leaf blight on older seedlings was found to be favored by crowding and dry soil, and prevented by the use of shade frames.

Fomes annosus and Two Species of Gymnosporangium on Juniperus virginiana: CARL HARTLEY.

Fomes annosus, a very dangerous root parasite in European coniferous forests, has been reported by Spaulding as parasitic on *Pinus Strobus* and *P. rigida* in New England. It is now found to cause the death of *Juniperus virginiana*, and apparently also of *Pinus tæda*, in Delaware.

Gymnosporangium germinale, and an undescribed *Gymnosporangium* which occurs on bark of all ages, have been found in connection with the gradual death of red cedars in Virginia and Maryland, and by Spaulding in Connecticut. The latter fungus was probably the chief cause of the disease.

Origin of Heterœcism in the Rusts: EDGAR W. OLIVE.

Accepting the view that the heterœcious æcidium cup forms of rusts were the last in evolutionary history and that their ancestral forms were autœcious and similar to the present lepto- and micro-rusts, the paper seeks to contribute toward the question of primary and secondary hosts.

Three arguments are presented toward proof that the present gametophytic, or æcidial, host was the primary host which bore the autœcious ancestor. It is claimed that from a cytological standpoint the main proof is furnished. The stage of the sexual cell fusions is regarded as at least equal in importance to the final stage of teleutospore formation, if not indeed as the most invigorating phase of the whole life history. From a cytological standpoint it seems inconceivable that the jump to an absolutely new host could have been made by the uninucleated basidiospores resulting from the germination of the teleutospores; since the jump would be thus made at a time when the reduction occurs which changes the fungus from the presumably more vigorous diploid generation back to the primitive haploid generation. It seems, rather, more reasonable to expect that the double nucleated æcidiospores, endowed with the greatest amount of vitality from the conjugation which has just preceded them, would be thus much better adapted to make the jump to another distinct host. Reasoning from analogy, we should naturally be led to expect at this stage, following the sexual fusions, new possibilities of development and consequently new possibilities for infection of foreign protoplasm.

Such forms as the morphological species of *Puccinia graminis* are regarded as furnishing another point in favor of this theory. The fewness and evident close relationship of the gametophytic hosts argues strongly that the barberry was the original host in this case and that the vigorous æcidiospores were able in their jump over to a secondary host to infect many sorts of grasses. The third and final point brought out in favor

of the theory is the fact that several species of barberry in various parts of the world act as teleutosporic hosts for several species of rusts, thus suggesting the possibility that at one time the barberry may have acted also as an ancestral host to the teleutospores of *P. graminis*.

Henry C. Cowles

The University of Chicago

THE CENTRAL BRANCH OF THE AMERICAN SOCIETY OF ZOOLOGISTS

The annual meeting of the American Society of Zoologists, Central Branch, was held at Iowa City, with headquarters at the State University of Iowa, on April 7 to 9. Officers were Edward A. Birge, University of Wisconsin, president; Michael F. Guyer, University of Cincinnati, vice-president; Charles Zeleny, University of Illinois, secretary-treasurer.

The meeting was an unusually successful one, the attendance being large and all but one of the large universities in the territory covered by this branch was represented by one or more zoologists.

There was an informal smoker at the Triangle Club on the evening of April 7, at which President MacLean, of the State University of Iowa, delivered an informal address. Other social features were a lunch held in the Bird Hall of the Museum of Natural History on Friday noon, and the annual dinner of the society at the Burkley Imperial on Friday evening, at which the annual address of the retiring president, Dr. Edward A. Birge, of the University of Wisconsin, was delivered.

The regular proceedings and reading of papers will be noticed later.

The following officers were elected for next meeting: Dr. C. E. McClung, of the University of Kansas, president; Dr. Henry F. Nachtrieb, of the State University of Minnesota, vice-president; Professor Herbert B. Neal, of Galesburg, Illinois, secretary. A committee on nomenclature to cooperate with the Eastern Branch, and ultimately with the International Association of Zoologists, in the revision of rules of nomenclature, was appointed, of which Professor C. C. Nutting, of the State University of Iowa, was chairman; the other members being Dr. H. B. Ward, of Illinois; Dr. S. W. Williston, of Chicago; Dr. C. A. Kofoid, of California, and Dr. C. H. Eigenmann, of Indiana.

The new laboratories of zoology, and the zoological museum were open for inspection and there was much favorable comment on the extent of the equipment, the size, and general style of the new building, and the exhibits in the museum.

SOCIETIES AND ACADEMIES

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

At the regular meeting held at the American Museum on March 14, 1910, Professor Charles B. Davenport presiding, the following papers were read:

Relation between Species and Individual in the Struggle for Existence: Dr. Alexander Petrunkevitch.

From examples taken from the groups of spiders and insects the speaker tried to show that the advantage of the individual is often opposed to the advantage of the species. Structures and habits dangerous to the individual but of use to the species are not uncommon. Their existence proves that the individual is "enslaved" by the species, which condition may be understood only if we consider the individual a mere carrier and protector of the germ. In the evolution of species not the characters of the fittest individual are selected and transmitted to the descendant, but those of the fittest to preserve the progeny.

A Case of Apparent Reversion among Gastropods: Miss Elvira Wood.

The ornament of *Potamidopsis tricarinatum* begins as two continuous spirals, passes through a stage with two rows of nodes and interpolates a third row of nodes in the adult. *Potamidopsis trochleare* has three rows of nodes in the young, later loses the median row and has in the adult two continuous spirals. This suggests reversion in the latter species, but in *P. tricarinatum* the upper spiral disappears before the introduction of the subsutural and median rows of nodes, while in *P. trochleare* the upper continuous spiral of the adult is developed from the subsutural nodes, hence the two spirals of the adult are not equivalent to the two spirals of the young *P. tricarinatum*. *P. trochleare* illustrates progressive development resulting in simplification of structures.

The Preparation of a Museum Anatomical Model: Mr. Ignaz Matausch.

The speaker gave an account of the successive stages in the construction of an anatomical model of a spider, for museum exhibition. He exhibited a number of dissected specimens of *Lycosa* upon which the model is based, as well as a series of wax models which are made preliminary to casting the final model.

L. Hussakof,
Secretary

SCIENCE

FRIDAY, APRIL 29, 1910

CONTENTS

BOTANICAL GARDENS[1]

RELATIONS OF BOTANICAL GARDENS TO THE PUBLIC

BOTANICAL gardens are important factors in public education, and are, at the same time, places for public recreation and enjoyment. They are highly specialized parks in which the plantations are formed and arranged primarily with regard to botanical facts and theories. Inasmuch as the great majority of their visitors have little time to spend, the information they carry away is more generally by impressions than by closer observation, although individual plants and groups of plants will often be remembered by casual visitors for long periods of time. Botanical gardens are, therefore, in effect museums of living plants, and the plants, treated as museum objects, suitably labeled, are installed to illustrate not only the objects themselves, but their relation to other objects. This museum feature is then a direct and immediate function in imparting information to the public.

The grouping of plants in botanical gardens is susceptible of widely different treatments, depending upon the character and the area of land available, the expense involved, and the facts and theories selected for illustration; also in the temperate zones, at least, upon the amount of greenhouse space available; also on the relative importance given to landscape considerations and upon the areas retained as natural forest, thicket or meadow. Facts and theories

[1] A symposium given before Section G, American Association for the Advancement of Science, at the Boston meeting, Tuesday, December 28, 1909.

capable of demonstration may be grouped in a general way as (1) biological relationships, (2) morphological and physiological features, (3) economic applications, (4) geographical distribution, (5) esthetic and landscape features. Practical considerations enter largely into groupings of any kind.

1. *Biological Relationships.*—In this installation it is sought to illustrate species of the various plant families in juxtaposition, the groups thus formed being located in relation to each other in some predetermined sequence; this sequence in recently planted botanical gardens is usually one which seeks to demonstrate not alone affinity, but the progressive increase in floral complexity, in other words, an evolutionary sequence. In such installations practical considerations render the sequence necessarily incomplete in any one set of plantations; sunshine-requiring herbaceous plants and shrubs can not be successfully grown close to trees, and some natural families, such as Papilionaceæ and Rubiaceæ contain herbs, shrubs and trees; climatic considerations prevent many families being brought into any one sequence; the biological grouping must then be obtained piecemeal; the most satisfactory and least expensive method is to grow the collections of trees (arboretum), of shrubs (fruticetum), of vines (viticetum), and of herbaceous plants, for the most part, at least, in separate areas; families principally composed of plants inhabiting climates other than that of the locality require artificial environment, such as glass houses for tropical and warm-temperate zone plants in gardens of the cold-temperate zone; it would be an interesting experiment to ascertain if arctic plants could be grown successfully in the temperate zones by some system of refrigeration. By a suitable arrangement of land and water, aquatic plants may be brought to some extent into juxtaposition with those of the same or related families requiring dry soil. One advantage in the biological grouping of large collections is the facility with which any species represented may be found when wanted. By the formation of a museum of prepared plants, of fruits, seeds and other organs, of photographs and drawings, the biological sequence adopted may be quite completely illustrated.

By indicating on the labels the native regions of plants biologically grouped, much simple information bearing on geographic distribution may be given. Casual observers are often as much interested to learn where a plant came from as to learn if it has any useful or ornamental features; the biological grouping also teaches them, by suggestion, that plants even from remote regions are related to other plants which they may know something about, and thus opens up new lines of thought for many people.

2. *Morphological and Physiological Features.*—The demonstration and illustration of structure and function presupposes some acquaintance with elementary botany, which the great majority of visitors do not at present have. The rapid development of nature-study in schools will render groupings of plants, arranged from these standpoints, much more generally significant than they are at present. It is possible and practicable to form groups of plants selected to illustrate the gross morphology and the simpler phenomena of physiology. These groups are more likely to be elaborated in gardens established primarily for students than in those laid out primarily for the use of the public. To a certain extent groupings illustrating ecological considerations can also be established with advantage, although areas remaining in the natural state are more useful.

3. *Economic Applications.*—Plants grouped and labeled with reference to their uses, or the uses of their products, are of very direct interest to the public, coming, perhaps, closer to ordinary lines of thought than any other features of the vegetable world, except those of beauty. The arboretum illustrates the subject of forest products without the necessity for a separate grouping of trees. Economic features of shrubs and herbaceous plants are best brought out by a special installation classified as food plants, drug plants, fiber plants and otherwise. As in the case of systematic grouping, economic installation has to be piecemeal, using glass houses for tropical economic plants and for those from warm-temperate regions. The elaboration of labels is of great importance and is, perhaps, the most expensive feature in the satisfactory display of useful plants. These subjects can be very thoroughly illustrated by the formation of museums of economic plant products and this is usually accomplished in highly developed botanical gardens. A system of cross references on labels between the living collections and the museum collections is a great desideratum. The expense of such a system is, however, very great, and it requires constant attention, because the death of a living plant, which can not at once be replaced, complicates it.

4. *Geographical Distribution.*—Groups of plants illustrating the botanical features of regions other than those of the locality of a botanical garden may be installed and this feature is given more or less prominence in the collections of many gardens. As mentioned under biological relationships, the information thus furnished is of immediate interest to the public and in some gardens geographical grouping has been adopted as a primary classification. Like the biological grouping, it has its limitations, and conditions of soil and climate make it necessarily imperfect and incomplete. Any attempt at growing trees, shrubs and herbaceous plants of a region close together in limited areas, while at first very interesting, ultimately fails because of the growth of the trees and the consequent shading out of the lower plants, unless the trees are cut out and their value in the grouping lost. Climatic conditions may be overcome by temporary geographical groupings, and in greenhouses some such groups may be installed quite satisfactorily. As to the relative value of the biological over the geographical as a primary classification in large public gardens, there is room for difference of opinion. An ideal method, if space and funds are available, would be to install both systems.

5. *Esthetic and Landscape Features.*—The public is more immediately interested in landscape effects and in plants from the standpoint of beauty than in most other features of botanical gardens. Well-built and well-kept grounds appeal to people as attractive places to visit. Natural woodlands, thickets and meadows also interest visitors, perhaps more keenly the residents of cities, and in some respects, especially from the standpoint of ecology, are as useful educationally as the artificial plantations. Landscape considerations applicable to parks and private grounds are not wholly adaptable to botanical gardens and this is often notably true in the unharmonious floral color contrasts necessitated by the grouping, although these may be minimized by careful selections. In most botanical-garden planting it is sought to display the plant in its natural form, so that extensive massing of individuals is avoided, although in large gardens space is often available for both massed and open planting. In the grouped plantations incongruous elements should be avoided, such

as establishing herbaceous flowering plants in plots among collections of trees and shrubs, which would divert attention from the main installation, or the introducing of exotic species into natural woodlands and thickets, which would give the public erratic ecological conceptions. Flower gardens, as such, are generally located separately from the botanically grouped plantations, for in them esthetic considerations are predominant.

The popularity of botanical gardens causes them at times to be over-crowded and problems relative to the control and circulation of large numbers of people arise which have to be met as well as possible. A comprehensive system of paths is essential; the majority of visitors instinctively keep to the paths, but it is undesirable in large gardens, at least, to actually restrict visitors to paths, for they could then come close to only a relatively small number of the plants installed, unless the path system was unduly elaborated and landscape considerations wholly neglected. A very small proportion of the public is intuitively destructive, and it is this small number of people that entail high expense for guards and keepers; legal punishment of offenders as a warning to others of mischievous proclivities is the only treatment available. In large gardens a driveway system and provision for conveyances for hire are also desirable, for many visitors are unable or unwilling to walk considerable distances.

The indirect relation of botanical gardens to the public lies in their function of adding to the knowledge of plants and plant products and the diffusion of this knowledge by publication and otherwise. Laboratories, herbaria and a library are essential adjuncts to the garden itself, and through investigations carried on in them and in the garden, additions to knowledge are constantly made. Of these additions to botanical information those of an economic character are the most immediately available for the public good, but the more theoretical additions to information may prove the more important in the long run.

From what I have said it will be clear that the function of botanical gardens in their relation to the public is somewhat different from their relations to college and university students, although, after all, this difference is one of degree rather than of kind.

N. L. Britton

THE PLACE OF BOTANICAL GARDENS IN COLLEGIATE INSTRUCTION

The splendid gardens under the direction of my predecessors in this discussion are well known to everybody, but this can not be true of the modest one of which I have charge. It will therefore be fairer to my comments on the subject if I say that it has been my duty, during the past fifteen years, to develop at Smith College, with due regard to reasonable financial restrictions, a garden which should be as well adapted as possible to collegiate instruction. It now includes these parts. First, there is an arboretum and fruticetum, of some 500 species, distributed, with regard partly to scientific arrangement and partly to pleasing landscape effects, over a campus of some thirty acres. Second, there is an herbaceous garden of some 700 species, arranged on the Engler and Prantl system. Third, there are three natural gardens, a rock garden, water garden and wild garden, the last as yet too young to be effective. Fourth, there is a range of well-built and suitably stocked greenhouses, nine in number with two attached laboratories. Upon the development of this garden rests my qualification for the part I have in this discussion. Naturally, it approximates to my idea of what a college botanical garden

should be. I wish to ask you to bear in mind that I speak upon gardens in collegiate instruction, and I shall keep strictly to that subject. Many of my conclusions do not apply at all to gardens of a different type—public, university or other.

Colleges differ much from one another in many features, but from our present point of view have these in common: First, they have only an undergraduate constituency, with practically no graduate work. Second, they have extensive grounds, usually of a rural character, which it is desirable to make as beautiful as possible. Third, they have a long summer vacation, with no summer schools or other instruction in that time. Of these conditions, to which collegiate botanical gardens must be adjusted, I shall speak in reverse order.

The long summer vacation is even longer, from the present point of view, than its number of weeks implies, for most of our students do not know enough to make profitable use of the garden at the opening of college, while the great number of social and other distractions at the end of the college year, not to mention the attractions of the native flora, seriously shorten its period of usefulness in the spring. Consequently the part of a botanical garden of most use in a college is that in which plants are alive and at work during the winter months, viz., the greenhouses. There is no question that, so far as scientific instruction in a college is concerned, suitable greenhouses are far more valuable than any outdoor garden.

Yet the long summer vacation does not by any means empty a college garden of its utility or desirability. The part which the vacation renders least useful is the herbaceous garden, arranged on the systematic plan, and I am not sure but that, if I were starting all over again, I would omit this part, closely identified though it is with the very idea of a botanical garden. Another kind which the long vacation would render of slight use is an ecological garden, that consisting of beds designed to illustrate types of structure, of dissemination methods, of cross-pollination mechanisms, and the like, for these would be well-nigh useless in early spring and late fall. Indeed, such observation and limited experimenting as I have been able to make on such beds leads me to disbelieve in their value aside from this limitation. It is impossible to have many of the forms illustrative of a certain idea in good condition at the same time; many of the forms best illustrating an idea are otherwise very unattractive and often difficult to grow; and even when such beds are developed, there are few people who can understand them unless they already know the subject with some thoroughness. I think it is usually true that gardens prepared to illustrate any artificial plan or idea, whether ecological, historical (*e. g.*, plants mentioned by Shakespeare) or other, are very unattractive in appearance and difficult to maintain effectively. These objections do not apply to natural gardens, viz., rock gardens, water gardens, wild gardens, in which plants are grown in natural surroundings; for these plants and places can be made so attractive as to draw appreciation and notice from all, and when suitably labeled, as of course all parts of the garden must be, they are decidedly instructive. We have at Smith College a very attractive rock garden, with a variety of exposures, containing many kinds of plants, from cliff dwellers to shade-loving ferns, and it amply repays its cost in the pleasure and the instruction it gives to its many visitors.

Another part of the outdoor garden that is well worth while despite the long vacation is the collection of trees and shrubs, especially as these are needed for the beau-

tifying of the grounds, which must receive attention whether a true botanical garden is developed or not. And this brings me to the second of the three conditions which must be met in collegiate gardens. All colleges desire to have their grounds as beautiful as possible, in order to create attractive surroundings for undergraduates, pleasing memories for graduates and favorable impressions for parents and benefactors. Now, to this end, the extensive use of trees and shrubs is indispensable. It would seem at first sight possible to combine a good landscape use of these with a systematic arrangement to illustrate relationships, but I have found, as no doubt have many others before me, that this is only partially possible. Thus, some families contain far more plants of attractive form than others. Imagine confining Coniferæ strictly to one section! Again, the proportion of trees to shrubs is so different in the various families that if these were confined to special areas some sections would have few or no trees and others no shrubs. Thus Leguminosæ have several ornamental trees, but hardly any ornamental shrubs, while this case is reversed in Rosaceæ, reaching an extreme in Caprifoliaceæ, which has no ornamental trees at all. Hence a strictly systematic arrangement can not be combined with good landscape results, and the best that can be done is to make sure that representatives of a given family are present in the appropriate area, even though not confined thereto. But on this plan, a very good collection of trees and shrubs, both pleasing to the eye and useful for study, can be assembled on a college campus. Moreover, trees and shrubs are in condition for study earlier in spring and later in autumn than herbaceous plants, and besides can be studied to considerable advantage all through the winter when herbaceous plants are not visible at all. Hence my experience has shown that of the outdoor garden, the trees and shrubs are far and away the most valuable part; next come natural gardens, and last of all the systematic garden. There is one other matter worth mention in this connection. The absolute necessity which colleges are under to keep their grounds attractive in any case, makes it possible to develop them as a botanical garden with comparatively little additional expense, for the extra cost of the other features is not relatively great. This applies in part also to the greenhouses, because where these are developed it is possible to give profitable and congenial employment to a good gardener during the winter, and consequently a more competent type of man can be kept, to the great advantage of all the interests involved.

Another matter which I am finding important in connection with the outdoor garden, but which applies equally to the greenhouses, is this. It is far better to concentrate upon good effects with a few things rather than upon the collection of many. In my own garden, we are reducing the number of species, but are giving better massing and surroundings to those we retain, which include especially the kinds the observer is likely to meet with again. Primarily this is in order to conform to an educational principle of which the importance steadily grows upon me, viz., that the scientific merits of a garden, or of anything else, are not of themselves sufficient to attract persons to their study, but attention must be paid to the peculiarities of human nature which demand that things shall be made attractive also. I therefore consider it important to so arrange plants that they will evoke attention and admiration first, on which basis instruction is far more easily given. And as the human capacity for attention and absorption is strictly limited, it is no use to

try to produce many such pleasing effects. A few very pleasing trees appeal more to human nature than do many only moderately pleasing. This principle fits perfectly, also, with my first condition of college instruction above mentioned, that only undergraduates make use of the garden, and the number of kinds they can utilize is not very great. In all scientific institutions, whether gardens, museums, or courses of instruction, we seem to pass first through an accumulation stage, in which completeness is the ideal and we try to collect all the kinds we can. Later we pass to a selection and individualization stage, in which we pick out the most essential objects and give each an ample and distinctive setting. We have passed into the second stage in our museums and to some extent in our instruction, but hardly yet in our botanical gardens.

I pass finally to the greenhouses, the importance of which I can not too strongly emphasize. These should be arranged, for convenience of both use and management, upon a climatic basis, including cool temperate, warm temperate, desert, stove and palm houses at least, furnished with a selection of well-labeled plants of the chief scientific interest, and with room for the growing of class material and for horticultural and physiological experiment, while the closer the attachment of the greenhouses to laboratories the better. I am here, as you may suspect, outlining the arrangement of the range developed under my charge, the practical working of which is extremely satisfactory.

The educational advantages of good greenhouses are too well known to all to need comment, but I may add another advantage not so obvious, viz., that they provide an extremely attractive and instructive place for visit in winter, not only by students but by their friends and visitors; and this is something of marked advantage in rural communities. Indeed, the instruction and enjoyment derived by the public from outdoor gardens as well as greenhouses constitute no small reason for their development. For not only do they attract attention and sympathy to a college, but they are also a wholly appropriate and serviceable form of college extension.

There are two warnings I would sound in connection with the greenhouses. First, they should be kept free from all entanglements in connection with the supply of ornamental plants for college functions. Such a use is bad for the plants, subversive of a scientific interest in them by the gardeners, and derogatory to the reputation of the greenhouses. The respect of the college community is far greater for a collection of plants kept exclusively for educational purposes, and for the scientific interests involved therein, than for any collection at their beck and call for social purposes. Second, they should be kept free from any attempt to make them help pay their own cost. The florist business is a highly specialized one, conducted, as a rule, on a narrow margin of profit, and no range of college greenhouses can earn any considerable amount without devoting thereto an amount of space and gardener's time wholly incompatible with any considerable attention to educational objects. Moreover, the feeling of local florists is quite sure to be aroused against an institution conducting a competition which they are sure to regard as unfair. These objections do not apply to the greenhouses of agricultural colleges; where the problems are different, and where it is essential that the students learn to raise plants for profit.

So, I may summarize my ideal botanical garden for a college by saying that it consists first of a good range of greenhouses, second of a collection of trees and shrubs,

primarily grouped artistically and secondarily on a systematic plan, third of natural gardens, and fourth of a limited systematic herbaceous garden. In all, selection and attractiveness of setting should be controlling principles.

W. F. Ganong

A UNIVERSITY BOTANICAL GARDEN

It requires some presumption for a mere novice to talk on this theme, after the fathers of our great botanical gardens have spoken from their ripe experience. One who neither grew up in a botanical garden already established, nor has had time to grow far with one established but a short two years ago, can hardly be expected to speak with authority. My only justification for complying with the request of your secretary to participate in this discussion is the fact that, in planning the botanical garden for the Johns Hopkins University, I have discovered what a goodly number of problems confront the beginner in this kind of work and how little detailed information is to be found in print that will aid him to overcome them.

I may therefore, perhaps, be permitted to say something of the purpose of our garden, of some of the difficulties encountered, and of such solutions of these, or part of them, as have either been worked out at Homewood or gathered from the experience of other gardens. These things are said not only in the hope of being of service to others who may be planning gardens, but also of evoking from others helpful criticism, that may be of aid to us in the work at Homewood.

That a botanical garden can be of great value to university students does not stand in need of proof to you of this audience. I desire, however, to suggest some of the particular ways in which I believe it may be most useful. If university students are what they should be, in aim and industry, it seems evident that access to a well-arranged botanical garden may advantageously replace class-room courses on certain aspects of gross morphology, floral biology and floristic geography, besides greatly enhancing the value of many of the formal courses on other subjects, given in lecture room and laboratory.

A botanical garden which is to be of use in the ways mentioned must suggest clearly what it is intended to illustrate. It must leave no suspicion of the aimlessness of a "cabinet of curiosities," but must show the purposefulness of a skilfully arranged museum—a museum in which (as an able museum director has said) the carefully selected specimens illustrate a well-devised series of labels, rather than one in which the labels are mere name-tags for more or less accidentally acquired specimens.

Such a definitely planned garden can well serve to extend the laboratory work and to concentrate the field work. For in the laboratory a student can not study enough plants minutely to comprehend them broadly; in the field he can not study any plant so thoroughly as to understand it deeply. The garden renders a larger variety of plants accessible, brings plants of different regions together for ready comparison, taxonomically, morphologically and physiologically, makes it possible to observe their activity and development more continuously and, finally, gives the most satisfactory opportunity of preserving them at critical stages for future study and comparison. The garden then does not replace either field or laboratory, but it does effectively link them.

If now we consider more specifically the functions a garden may serve we may summarize them thus:

1. It can illustrate certain phenomena of plant life which may be observed directly,

as the plants grow in the garden or the accompanying greenhouse. Because they can be observed continuously the student gains a familiarity with them and their phenomena which is not possible from a single contact with them, when they are brought out once a year, in a laboratory course.

2. The garden and greenhouse have an important use as a source for the material needed in instruction and research, in laboratory and herbarium.

3. The existence of a garden insures the presence of propagating grounds, tools and a trained gardener, all of them necessary to the carrying on of researches in plant breeding or other work involving extensive cultures, such as are often made in studies of variation and experimental morphology.

4. Not the least important feature of a garden, especially one on a university campus, is that it shall prove attractive from its design and the plants in it, entirely aside from its scientific interest.

I shall, from this on, make casual reference only to the last three of these functions, but shall dwell more fully on the first, *i. e.*, the use of a garden in botanical instruction. This is, I believe, the function which chiefly determines the arrangement of most botanical gardens now in existence, the only other potent influence being, perhaps, the artistic one.

The botanical facts and principles that can well be illustrated in a botanical garden may be grouped under the following heads: (1) plant structures, (2) plant phylogeny, (3) plant activity or physiology, (4) plant ecology, (5) floristic plant geography, (6) economic plants. We may now take these up in the order mentioned.

1. Plant structures may be illustrated by examples, first, of vegetative organs, in their various modifications, and secondly by examples of reproductive organs, such as those for vegetative multiplication, for asexual reproduction, and for sexual reproduction, including such accessory reproductive organs as flowers and fruits.

2. Plant phylogeny may be illustrated by the natural system of Engler, as a modern interpretation of the kinship of plants, also by selected examples of older "natural systems" of historical importance, such as the systems of Jussieu, Braun and Eichler. Finally, examples of plant breeding may be made to illustrate the means of origin of new types of plants, such as sports, mutants and hybrids.

3. Types of plant activity that may be readily illustrated in a garden are: first, those connected with growth—showing its rate, direction and seasonal variation; secondly, sleep movements; thirdly, movements of leaves of compass plants; fourth, the movement of irritable or sensitive leaves; fifth, and finally, those movements of the flower, or its parts, which aid in the process of pollination, of which many interesting examples may be shown.

4. In plant ecology we may well illustrate certain important habitat-relations and growth-forms. Those that can be most satisfactorily shown are chiefly relations to edaphic factors, though the alpinum and the greenhouse give some opportunity of suggesting relations to climatic factors. Other ecological facts may be illustrated by examples of plant communities. Under this head, when enough ground is available, may be shown plant formations, chiefly native ones, as forest, bush, meadow, etc. Finally, ecological guilds, or types of symbionts, may be illustrated by lianes, epiphytes, saprophytes and parasites. This latter series takes but little space in the garden, but much ingenuity is required to make them develop typically.

5. Floristic plant geography may perhaps be best illustrated not merely by

groups of plants from the different formations of a general floristic region, but also, where space permits, by like formations from different regions. These should be as complete as possible and may well be selected to show similar growth-forms occurring in widely different species, genera, or even families. In Atlantic North America, for instance, bits of Alaskan, Manchurian or Scandinavian forest, in which all the elements from the herbs of the forest floor to the dominant trees are represented, would prove exceedingly interesting for comparison with our native forest and with each other.

6. Economic plants may be represented by those plants which yield the chief vegetable products of commerce, by types of ornamental plants and by noxious plants, *e. g.*, weeds, poisonous plants and fungus parasites. The practical application of plant breeding may also be illustrated here by examples showing the difference often existing between the wild parent and the cultivated offspring, together with illustrations of the methods of breeding and cultivation by which the modification of cultivated types is produced.

These, I believe, are some of the facts and principles which we may hope to illustrate in a botanical garden. The realization of these expectations demands, I am finding, persistent industry and unfailing optimism, for obstacles arise unexpectedly, and success in new fields is far from certain.

In the garden of the Johns Hopkins University, at Homewood, we are trying to do some, at present not all, of the things which I have just outlined. I wish now to try to tell you just what these are, how we have planned them and something of the practical expedients by which we have managed to get plants to grow where we wish them. I may also refer to the devices for labeling which are being used, in the attempt to make the garden intelligible not only to the student, but also to the general public, to whom the garden is open.

The area at present planted at Homewood, the new university site, is a flat-topped knoll, about two acres in extent, surrounded on three sides by a native forest of oak, chestnut, beech and tulip. The garden is laid out in a strictly formal manner, in view of the fact that it is to form the western termination of the transverse axis of the proposed group of university buildings. It will ultimately be overlooked by the terrace on which the westernmost buildings are to be located.

The boundary of the garden is marked by two parallel lines of hemlock hedge with a wide walk between them. The entire garden is divided into quarters by walks running from the middle of each side to a large pool in the center. Each quarter is broken by gravel walks into 18 beds with myrtle borders. These beds contain altogether about 500 planting spaces ($2\frac{1}{2} \times 3\frac{1}{2}$ feet), making something over 2,000 planting spaces for the whole garden. The greenhouse, physiological laboratory and an acre of ground for propagating purposes lie directly south of the garden.

The garden consists of four sections. Section I. illustrates the chief types of vegetative organs of plants. The arrangement of these types is in part a morphological, in part a biological one. Section II. is given to the illustration of the structure and biology of the reproductive organs of plants, *i. e.*, of sporangia, flowers, seeds, fruits, etc. Section III. illustrates the genealogy of plants as indicated by their classification. It includes illustrations of the various kinds and degrees of kinship, of species, genus and family, of hybrids and mutants, of a number of historically important systems of classification and of

the modern system of Engler. Finally, it also illustrates in some detail the variety in structure and in geographical distribution, found among the members of a few selected families of seed plants, *e. g.*, of Ginkgoaceæ, Saururaceæ, Liliaceæ and Compositæ. Section IV. contains a selected series of useful and of ornamental plants, chiefly those native to temperate regions, though a few of the more important tropical, economic plants are shown.

In the further development of the botanical garden it is planned to illustrate various types of plant communities, some of the important facts of geographical distribution and the habitat relations of various growth-forms. It is expected that the general planting of the Homewood grounds may be carried out in such a way that the groups of shrubs and trees so used shall have scientific as well as an ornamental value.

The efficiency of a garden as an educational factor is determined, in large degree, by the design and arrangement of the labels used to designate the individual plants and the plant groups shown.

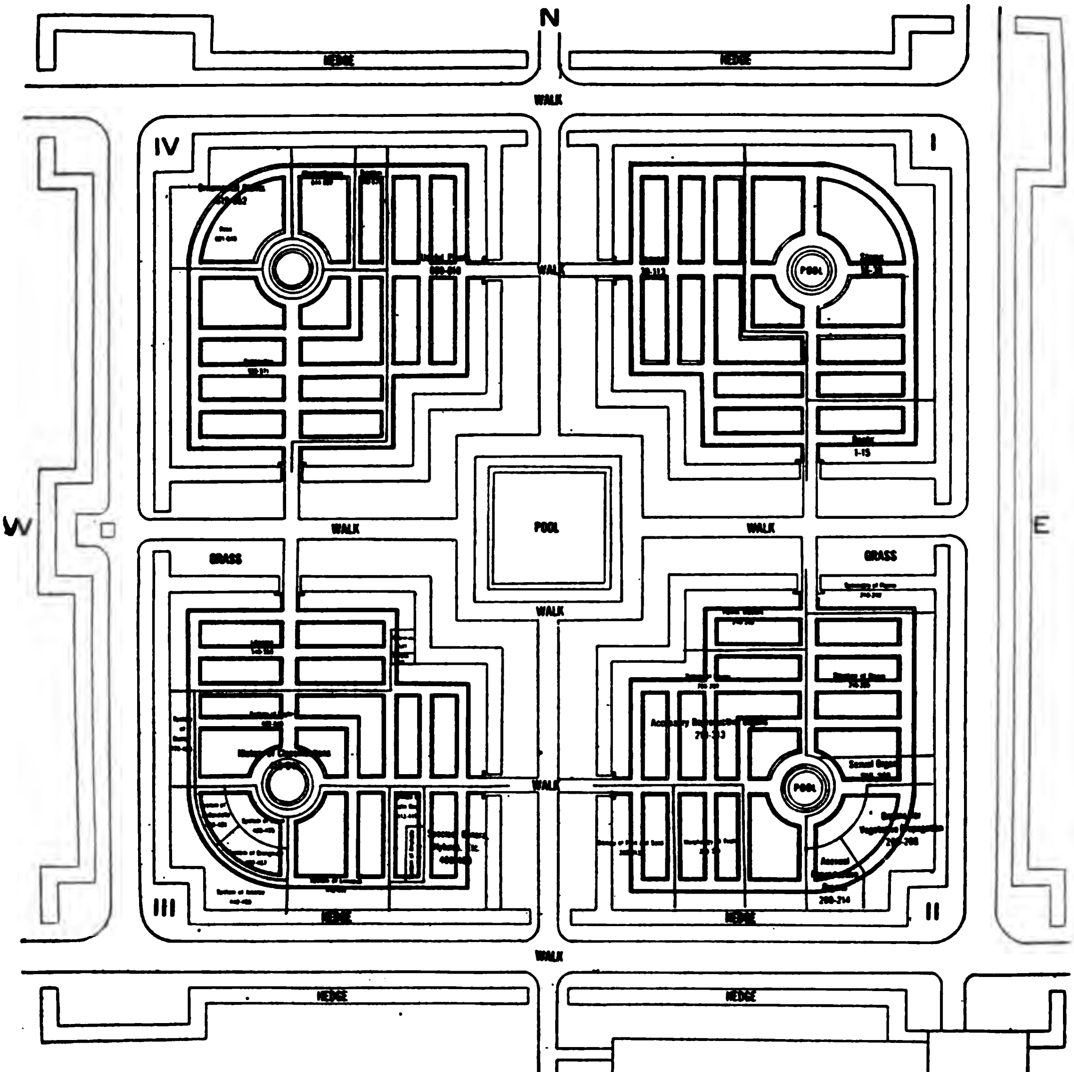
The series of types of structure, relationship, etc., shown in each section of the garden at Homewood, is divided into successively subordinate groups. These groups are: division, subdivision and groups without names but designated by letters and signs.

Each individual type of structure, etc., is designated, in this guide and on the labels, by a number. All species used in the garden to illustrate a given type bear the number of this type on their labels. In the guide this number is found at the extreme left of the page, opposite the name of the group. In the garden these numbers are at the bottom on the group labels and at the top on the species labels.

The numbers at the bottom of a group label indicate the kinds and number of types of structure included in the group. For example: the numbers 16–19 on the label for subterranean stems indicate that the types included in this category are those bearing these numbers, in the guide and on the labels, *i. e.*, rhizomes, tubers, corms and bulbs; the numbers 288–290 on the label for indehiscent fruits indicate that this group includes the achene, nut and caryopsis.

The number at the top of a species label indicates the type of structure, relationship or economic plant illustrated by this species. A reference to this number in the guide, or in the garden, to the nearest group-label bearing this number, shows what is illustrated by the species. For example: any species label bearing the number 8 indicates that the plant illustrates the use of the roots as tendrils; the number 529 indicates that the species belongs in the series Rosales of Engler; the number 600 designates the species as a cereal.

The location in the garden of the illustrations of any particular group of structures or relationships may be readily seen by a comparison of the outline of the chief groups (p. 653) and the plan showing the arrangement of beds in the garden (figure, p. 652). On the latter the area devoted to each division is indicated by heavy lines between beds. Section I. is in the northeast quarter of the garden, the types being numbered from 1 to 113. Section II. is in the southeast quarter (Nos. 200–313). Section III. is contained chiefly in the southwest quarter (Nos. 400–558), but partly in the northwest quarter (Nos. 559–571). Section IV. is also contained in the northwest quarter (Nos. 600–652). The sequence of the types within each quarter is readily seen from the numbers on the labels. These are arranged in regular succession along the beds as far as possible,



PLAN OF GARDEN
OF JOHNS HOPKINS UNIVERSITY AT HOMEWOOD

and, where this succession has been broken, an index label has been used to show where the next following numbers are to be found.

By means then of the continuous series of numbers, one for each ultimate unit of structure or relationship shown, it is believed that confusion may be avoided and the visitor be at liberty to note as much or as little as he desires of the assembling of these units into successively larger groups, which are indicated in the guide, and by group labels in the garden.

With such a definite series of structures

BOTANICAL GARDEN AT HOMEWOOD

CHIEF GROUPS IN THE GARDEN

SECTION I. VEGETATIVE ORGANS.
  Division I. Roots. 1–15.
    Subdivision I. Subterranean Roots.
      " II. Aquatic Roots.
      " III. Aerial Roots.
      " IV. Parasitic Roots.
  Division II. Stems. 16–38.
    Subdivision I. Leafless Stems.
      " II. Foliage Stems.
      " III. Branch Systems.
  Division III. Leaves. 39–113.
    Subdivision I. Cotyledons.
      " II. Foliage Leaves.

SECTION II. REPRODUCTIVE ORGANS.
  Division I. For Vegetative Propagation. 200–208.
    " II. For Asexual Reproduction. 209–214.
    " III. For Sexual Reproduction. 215–313.
    Subdivision I. Sexual Organs.
      " II. Accessory Reproductive Organs.

SECTION III. PLANT RELATIONSHIP.
  Division I. Degrees of Relationship. 400–409.
    " II. History of Classifications. 410–545.
    Subdivision I. System of Aristotle.
      " II. " " Ray.
      " III. " " Linnæus.
      " IV. " " de Jussieu.
      " V. " " de Candolle.
      " VI. " " Brongniart.
      " VII. " " Braun.
      " VIII. " " Eichler.
      " IX. " " Engler.
  Division III. Selected Families. 546–571.

SECTION IV. ECONOMIC PLANTS.
  Division I. Useful Plants. 600–618.
    " II. Ornamental Plants. 619–652.

OUTLINE OF THE TYPES OF PLANT ORGANS, OF PLANT RELATIONSHIPS AND OF ECONOMIC PLANTS ILLUSTRATED IN THE GARDEN*

SECTION I. VEGETATIVE ORGANS.
  Division I. Roots.
    Subdivision I. Subterranean Roots.
1 Tap Roots.
2 Fascicled Roots (clustered roots).
3 Fibrous Roots.
    Subdivision II. Aquatic Roots.
4 Bottom Roots.
5 Floating Roots.
    Subdivision III. Aerial Roots.
6 Prop Roots.
7 Protective Roots (root-thorns).
8 Tendril Roots.
9 Attaching Roots (of air plants).
10 Attaching and Absorbing Roots (of air plants).
    Subdivision IV. Parasitic Roots.
11 Water-absorbing Roots.
12 Food-absorbing Roots.
    Subdivision V. Symbiotic Roots.
13 Mycorhizal Roots (with fungus threads instead of root hairs).
14 Bacterial Roots (with bacterial tubercles).
15 Nostoc-holding Roots.
  Division II. Stems.
    Subdivision I. Leafless Stems (*i. e.*, with scale-like leaves).
    A. Subterranean Stems.
16 Rhizomes.
17 Tubers.
18 Corms.
19 Bulbs.
    B. Aerial Leafless Stems.
20 Cactoid Stems (fleshy green stems).
21 Phyllocladia (leaf-like stems).

* All types illustrated in the garden are indicated in this list. Each type is given a number here, which also will be on the top of the label of every species used to illustrate that type.[1]

and systematic sequences to be illustrated in a set of formal beds, we encounter at once the very practical difficulty of making plants grow in proximity in the garden that occupy quite different habitats in nature. Under these conditions one is tempted to do what one of my correspondents has done—*i. e.*, rearrange the families of plants in such a way that families with like habitat-requirements come near together. This correspondent, a landscape gardener, points out the horticultural inconveniences of the Engler system, and suggests that the Eichler, and Bentham and

[1] This page is reprinted from "Guide to the Botanical Garden at Homewood."

Hooker systems are—to quote—"better adapted to the artistic ensemble of a hardy garden." He then proceeds to give—to quote again—"a revision of the Hookerian cohorts that is adapted to copyrighted garden plans of the author previously published."

If, however, one is not bold enough to remodel the whole natural system to suit his particular garden scheme he must find other means of making system and soil fit—and this often presents considerable difficulties.

To make aquatic and bog plants grow beside related forms inhabiting drier soils, we tried several devices. The first of these was the small brick pool common in European gardens. But these are expensive to build and are liable to be burst and rendered useless by freezing. We have, therefore, substituted two-gallon earthenware kitchen bowls, with sloping sides inside and out. These can stand freezing, and can be made invisible in the garden by sinking them to the rim in the soil. Well-developed specimens of many aquatic plants were made to grow in these during the past summer. By the use of these bowls it is possible to have a miniature bog at any point in the garden where it is needed.

Provision for larger aquatic plants is made by three concrete pools. For swamp plants there is a bog bed, 15×30 feet, filled with peaty soil. This has a water-tight brick border, two feet deep, and a water supply from taps at both ends. In this bed fine specimens of *Woodwardia virginica, Rhododendron viscosum, Hibiscus moscheutos, Decodon verticillatus* and others have flourished finely.

In a bed of sand, with a slight admixture of humus, fine clumps of *Opuntia vulgaris* are spreading vigorously and other xerophytes promise to do well.

Another difficulty encountered in garden-making of this sort is that of getting shade plants to grow in the open beds. To accomplish this we have been using small dogwoods, which can readily be kept within bounds, and in the shade of which many mosses, ferns, orchids and other plants of the forest floor are growing well.

Finally, a very important detail of the management of a garden is the selection of labels that shall be inexpensive and at the same time legible and durable. Profiting by suggestions from older gardens we have devised three types of zinc labels that are proving very satisfactory. The simplest of these is a stake label an inch wide and six inches long. On this the accession number is stamped across the top with a steel stamp, and the name is written directly on the metal with platinum tetrachlorid. These labels are used for all plants not provided with show labels. Another type of label is $1\frac{3}{4}$ inch wide and 8 inches long. It is painted gray, the name is then stamped on it with printer's ink by means of a rubber stamp. After the ink is dry the label is covered with spar varnish. These are used for show labels on pot plants in the greenhouse. The show labels used for all group and species labels in the garden are rectangular zinc labels, of various sizes from 3×5 inches up to 5×12 inches. These are hung by a fold of the upper edge, to a heavy wire staple, the name is printed and the varnish used for protection as in the show labels in the greenhouse.

The advantage of these labels is that they can be made readily, of any size, by any tinsmith, since they do not involve the use of expensive dies.

Such are some of the practical devices which contribute toward making the garden useful. Some of these are probably used in other gardens, but I have thought it worth while to mention them here be-

cause I have not been able to find information of this sort in print.

It is to be expected that what now seem satisfactory devices for carrying on the work of the garden will prove capable of much improvement in the future, aided by experience gained from other gardens as well as in our own. It will always be one of the chief aims of the garden at Homewood to discover what a garden is capable of doing for the botanical student and investigator and how it can do this best.

DUNCAN S. JOHNSON

THE RELATION OF APPLIED SCIENCE TO EDUCATION[1]

THE dative of indirect object is used with most Latin verbs compounded with ad, ante, con, in, inter, ob, post, pre, pro, sub and super, and sometimes circum; the elements essential for the growth and maturity of the plants which furnish, directly or indirectly, the food and clothing for the human race are carbon, hydrogen, oxygen, nitrogen, phosphorus, potassium, magnesium, calcium, iron and sulfur, and possibly chlorin, and I think I am expected to discuss the general question whether there may be as much educational development in a study of these elements, for example, and of their application to the preservation of American soil and to the preservation of American prosperity, civilization and influence, as in learning a like number of Latin prepositions and their application to language development, and to philological research.

The question is, whether the culture of corn roots and the investigation of corn-root insects and diseases or the culture of clover roots, with their millions of symbiotic bacteria and their wonderful power to transform much of the impoverished lands of that part of Illinois whose name is "Egypt," and much of the exhausted and abandoned lands of India, whose fame is famine, into fruitful and valuable lands, may serve as well for the development of the mind and for the advancement of education and civilization, as the culture of Greek roots, and Sanskrit roots, and Hindu roots, from which we learn that the people of India, of whom only one man in ten, and only one woman in a hundred, are able to read and write—from which we learn that these people are our own cousins; that many words still live in India and in America that have witnessed the first separation of the northern and the southern Aryans; and, in the words of Max Müller:

> These are witnesses not to be shaken by any cross examination. The terms of God, for house, for father, mother, son, daughter, for dog and cow, for heart and tears, for axe and tree, identical in all the Indo-European idioms, are like the watchwords of soldiers. We challenge the seeming stranger, and, whether he answer with the lips of a Greek, a German or an (East) Indian, we recognize him as one of ourselves. There was a time when the ancestors of the Celts, the Germans, the Slavonians, the Greeks and Italians, the Persians and Hindus, were living together beneath the same roof.

Why has the southern Aryan civilization developed but one school for every five villages, while the northern Aryan, save in Russia, opens to every child the door of the school which leads on, for those who will, to the college and university? Why? Because only a prosperous nation can afford the trained intelligence or education of its people.

Education in America is not the cause, but the product, of our prosperity; and, thus far, the prosperity of this nation is due to our conquest of the former inhabitants and to the consequent acquisition of the great natural resources of this country,

[1] One of the papers presented February 19, 1910, before the Illinois State Academy of Science in the symposium on the "Relation of Pure and Applied Science."

including, primarily, vast areas of rich virgin soil; and, secondarily, immense supplies of timber, coal, and iron.

American prosperity has done more than educate Americans; it has educated western Europe, first of all by relieving the over-crowded condition of those impoverished lands, and subsequently by making large direct contributions to European prosperity, in supplying cheap food and fertilizer and a good market for European products, manufactured in large part from the low-priced raw materials secured from this and other new countries.

Applied science has already made some contributions to American education and civilization, and so far as its use in the schoolroom is concerned, applied science, as an educative agency, is not exceeded in value by any other instrumentality. Its very general acceptance by teachers and students in our leading educational institutions does not prove its value, but does prove that its value is being appreciated; and I need not remind you that pure science is the foundation of applied science.

While education has not been in any sense the prime cause of our national prosperity, the future prosperity of America depends absolutely upon the application of science and education to industry. For three full centuries America has lived upon the spoils of conquest and inherited wealth and resources, and for three full centuries America has wasted her substance or scattered it abroad. But even among nations there is a limit to inherited wealth. The land which flowed with milk and honey is now almost a barren waste, supporting only wandering bands of marauding Arabs and villages of beggars.

Truly the two most characteristic attributes of rich young America are wastefulness and bigotry. Other nations have risen to positions of world power and influence and fallen again to poverty, ignorance and insignificance. Thus far American history has been in large part a repetition of the history of nations long since gone to decay.

Following the rise and fall of the great empires of Babylon, of Carthaginia and of Greece, the Roman Empire also rose and fell. From what cause? Some tell us that the fall of those great empires was due to the development of pride and immorality among their peoples, forgetting the fact that civilization tends rather toward peace and security, and that universal education depends and must depend upon material prosperity. Poverty is at once helpless and soon ignorant.

History tells us that Roman agriculture declined until a bushel of seed brought only four bushels in the harvest—declined until the high civilization of the Mediterranean countries passed into the dark ages which covered the face of the earth for a thousand years, until the discovery of a new world brought new supplies of food, renewed prosperity, and new life and light to western Europe; but the dark ages still exist for most of our own Aryan race in Russia and in India, where, as an average, day by day, and year by year, more people are hungry than live in the United States, where the average wage of a man is fifty cents a month, where famine rages always, and where the price of wheat sometimes rises to a point where six months' wages of a working man are required to buy one bushel. This is the condition where the absolute needs of the population exceed the food supply; and just so sure as the intelligent and influential men and women of America continue to ignore the material foundation upon which national prosperity depends, just so sure will future dark ages blot out American civilization.

That vast areas of land that were once

cultivated with profit in the original thirteen states are now agriculturally abandoned is common knowledge; that much of the land in all adjoining states is in the process of abandonment is known to many; and that the common lands in the great agricultural regions in central United States are even now in process of the most rapid soil depletion ever witnessed is known to all who possess the facts.

Already the question of food has begun to exert pressure in this country. Already the masses, the common people, the "ninety per cent.," must consider a reduction in their standard of living. Poverty and degeneracy are even now making such demands upon the revenues of the state that education and research already suffer from inadequate support; and the only hope of the future lies in the application of science and education to the control of industry and to the control of population; and let us never forget that agriculture is the basis of all industry, and that the fertility of the soil is the absolute support of every form of agriculture.

Some will say that the economic conditions have been such that the depletion of the lands of the eastern states has been a necessary sequence, and that the restoration of those lands will now follow as an economic necessity. I beg of you, do not accept any such theoretical deductions. If systems of permanent progressive agriculture are ever to be adopted anywhere in this country, it must be done while the landowners are still prosperous. Some investment is necessary for the restoration of depleted soil, and poverty makes no investments. Much of the abandoned lands of America are far past the point of possible self-redemption. They were depleted not because of any economic necessity, but because of ignorance, and the fault lies not with the farmers and land owners, but with the educators who even until the present generation have taught almost everything except the application of science to agriculture. The fault lies also with the statesmen who, as James J. Hill says, have "unduly assisted manufacture, commerce and other activities that center in cities, at the expense of the farm."

There was no need whatever that the cultivable farm lands of the eastern states should have been depleted. Lying at the door of our greatest markets, with the application of knowledge and with such encouragement as should have been given, those lands could easily have been preserved and even increased in fertility until their present value would have been not five dollars, but five hundred dollars an acre.

Even now are the young men of the United States putting ninety million dollars a year into Canadian farms. Why? Because they were not taught in the schools that by investing those millions in the application of science to agriculture they can remain in the United States and secure greater profit and also save our soils from depletion; yes, make our partially depleted lands even more productive than they ever were, and at the same time provide the food that will soon be required to feed our own children.

Why do we permit the annual exportation of more than a million tons of our best phosphate rock, for which we receive at the mines the paltry sum of five million dollars, carrying away from the United States an amount of the only element of plant food we shall ever need to buy, that, if retained in this country and applied to our own soils, would be worth not five million, but a thousand million dollars, for the production of food for the oncoming generation of Americans?

Why this exportation? Because the present owners of American land learned only the art of agriculture and were never taught the science of farming; and it may well be repeated that the responsibility rests not with the farmer, but with the statesman and the educator.

Note well the following facts:

During the past dozen years the average acreage in corn and wheat in the United States has been increased by 30 per cent.; but notwithstanding the enormous increased production thus made possible, we have been obliged to decrease our average exportation of corn and wheat from nearly one fourth to only one tenth of our total production; and at the same time the average price of these great basic food materials has increased by 52 per cent., corresponding approximately to the increase in the value of land in the great corn and wheat states, and to the consequent and inevitable general advance in the cost of living.

You will remember that the population of the United States has increased 100 per cent. in thirty years, and without doubt will number more than 90 millions in 1910; but, notwithstanding the great areas of rich virgin lands brought under cultivation in the west and northwest, and notwithstanding the abandonment of great areas of depleted soil in the east and southeast, during the last forty years the average yield per acre of these two great grain crops has not even been maintained according to the twenty-year averages of the crop statistics of the federal government for the forty years from 1866 to 1905, as reported in the 1908 year book of the United States Department of Agriculture.

Shorter periods might be selected which would give apparent indications of a different tendency, but less than twenty-year averages are not trustworthy for ascertaining the average yield per acre; and these two twenty-year averages show that the decrease in yield of corn has exceeded the slight increase in yield of wheat, much of which, it should be remembered, is now grown on land less than forty years under cultivation. And this statement holds not only for the entire United States, but also for the great north central grain belt, including Ohio, Kansas, North Dakota and the ten other states lying within that triangle.

Thus, in this boasted "granary of the world," the records of forty years show that the average yield of wheat has increased one half bushel per acre, while the average yield of corn has decreased two bushels per acre.

Why should the average yield of corn in the United States be only 25 bushels per acre and the average yield in Illinois be only 35 bushels per acre, when the average yield upon the farm of the University of Illinois, on normal soil under practical, profitable and permanent scientific systems of farming, is 87 bushels per acre?

There are at least four factors involved in the solution of the problem of maintaining prosperity, civilization and universal education in this country. These four factors may be classified as exploitational, scientific, legal and economic.

1. Further exploitation of our remaining virgin soils, as by irrigation and drainage, neither of which is of large significance in comparison with the magnitude of our present agricultural development.

2. The restoration, by practical scientific methods, of depleted lands and large increase in productive power of practically all lands now under cultivation. This is the only great positive factor.

3. The legal control of increase in population by the enactment and enforcement of suitable laws.

4. The reduction in the standard of living, by extending the tendency already enforced to some extent, as in the gradual withdrawal of meat and other valuable food products from the daily diet, and adopting such standards as are common in China and Japan, where beef, butter and milk are practically unknown.

The greatest study of mankind is not man, but the application of principles upon which depends the preservation of man's prosperity and civilization; and this study must not only include the application of science to raise high the limitations of the production from the soil of necessary food supplies, but it must also include the application of sense in placing some just and necessary limitations upon the reproduction of the least fit of human kind.

CYRIL G. HOPKINS
UNIVERSITY OF ILLINOIS

ATTENDANCE OF STUDENTS AT FOREIGN UNIVERSITIES

The following table, which I have recently compiled, may be of interest to your readers.

These figures of attendance were furnished to the U. S. Commissioner of Education by the editor of *Minerva*, were printed by him in his annual report for 1908 (not summarized as here, but in detail for each institution, country by country), and are probably as complete as any which could be readily found or compiled. That these totals understate, rather than overstate, the attendance in some of the countries which have not taken the pains to prepare complete official statistics is highly probable; thus in SCIENCE, September 24, 1909, there are given figures quoted from Professor B. Menschutkin, writing in *Nature*, which claim a total attendance of students in the higher educational institutions of Russia for the years of 1908 and 1909, of 76,900, with the surmise of possibly 20,000 more in private higher colleges in different towns—a total of 96,900 as opposed to 54,208 given in the table for the year 1907 as a total of the figures furnished by the editor of *Minerva*.

I have not *Nature* at hand, but as quoted in SCIENCE Professor Menschutkin fails to state from what source his figures were drawn and I have therefore not been able to check them and, consequently, have not felt free to use them in this table in place of those having the sanction of "official" source. My own belief is that the total for Norway is considerably less than it should be if it represented complete results, but I have not, after due search, been able to find official supplementary figures. The same may be true in the case of some other countries, but the table is significant enough as it stands in the showing it makes of the widespread interest and participation in higher education.

Country	Population	Number of Students in Higher Educational Institutions, 1906–7	Population per Student
United States	83,941,510 (Est. 1906)	283,395[1] 212,956[2]	296 394
Switzerland	3,463,609 (Cen. 1905)	10,511	330
France	39,252,267 (Cen. 1906)	50,935	771
Denmark	2,605,268 (Cen. 1906)	3,363	775
Germany	60,641,278 (Cen. 1905)	73,020[3]	830
Austria-Hungary	46,973,359 (Est. 1906)	51,691	909
Greece	2,631,952 (Cen. 1907)	2,836	928
Italy	33,640,710 (Est. 1907)	33,174	1,014
Belgium	7,238,622 (Est. 1906)	7,139	1,014
Netherlands	5,672,237 (Cen. 1906)	5,435	1,044
United Kingdom	44,100,231 (Est. 1906)	41,305[4]	1,068
Spain	18,831,574 (Cen. 1900)	15,642	1,204
Roumania	6,585,534 (Est. 1907)	5,336	1,234
Sweden	5,337,055 (Cen. 1906)	4,032	1,324
Portugal	5,423,132 (Cen. 1900)	3,923	1,382
Norway	2,321,088 (Est. 1906)	1,500	1,547
Servia	2,676,989 (Est. 1904)	1,022	2,619
Russian Empire	149,299,300 (Est. 1906)	54,208	2,754
Bulgaria	4.035.620 (Cen. 1905)	1,324	3,048

Population from "Statesman's Year Book," 1908. Number of Students from "Report of U. S. Commissioner of Education," 1908, Vol. I.

GUIDO H. MARX

ELECTIONS TO THE AMERICAN PHILOSOPHICAL SOCIETY

AT the annual elections for members of the American Philosophical Society on April 23, fifteen residents of the United States and five

[1] Including normal schools.
[2] Excluding normal schools.
[3] Including hearers.
[4] Excluding 22,159 "evening students."

foreign residents were, according to the custom of the society, elected to membership, from among the forty-nine nominations. The members elected, together with the credentials presented by their proposers, are as follows:

Simeon Eben Baldwin, LL.D., New Haven. Professor of Constitutional and Private International Law in Yale University. Justice of the Supreme Court of Errors of Connecticut, 1893–1906, and Chief Justice, 1906–1910. President of American Bar Association, 1890; of American Social Science Association, 1897; of International Law Association, 1899–1901; of American Historical Association, 1905; of Association of American Law Schools, 1902. Author of "Baldwin's Connecticut Digest"; "Cases of Railroad Law"; "Modern Political Institutions"; "American Railroad Law"; "American Judiciary."

Francis G. Benedict, Ph.D., Boston. Director of the Nutrition Laboratory of the Carnegie Institution; Professor of Chemistry at Wesleyan University, 1896–1905; Physiological Chemist of Nutrition Investigations of United States Department of Agriculture, 1895–1907. Author of extensive experimental investigations in nutrition, based largely on studies with the respiration calorimeter and of numerous contributions to organic and physiologic chemistry. Member of the American Chemical Society, American Physiological Society, Deutsche Chemische Gesellschaft, etc.

Charles Francis Brush, Ph.D., LL.D., Cleveland, Ohio. Electrical Engineer. Designed the Brush Series of Arc Lighting Dynamo, and the Series Arc Lighting System. Has for many years devoted himself to scientific research. Decorated by the French Government in 1881 for achievements in electrical science. Received the Rumford medal of the American Academy of Arts and Sciences in 1899.

Douglas Houghton Campbell, Ph.D., Palo Alto, Cal. Professor of Botany at Leland Stanford University. The most prominent student of the structure and development of the higher cryptogams in this country, and has an expert knowledge of the embryology of higher plants. Author of valuable books and papers on the comparative morphology of plants, evolution of plants, structure and development of the mosses and ferns, and embryology of the simpler angiosperms.

William Ernest Castle, Ph.D., Payson Park, Belmont, Mass. Professor of Zoology at Harvard University; student of heredity by experimental methods. Author of works of importance on heredity of sex, inheritance of characteristics in rabbits, mice and guinea pigs.

George Byron Gordon, Philadelphia. Assistant Professor of Anthropology and Director of the Museum of Archeology of the University of Pennsylvania. Author of various papers on American Archeology in the publications of the Peabody Museum, and of the Museum of Archeology of the University of Pennsylvania.

David Jayne Hill, LL.D., American Embassy, Berlin. Diplomatist, jurist and author. President of Bucknell University from 1879–1888, and of Rochester University from 1888–1896; Assistant Secretary of State, 1898–1903; United States Minister to the Netherlands, 1905–1907; Ambassador to Germany since 1907; Member of the Permanent Administrative Council of The Hague Tribunal. Author of a "Life of Washington Irving," "Elements of Rhetoric," "Life and Works of Grotius," "A History of Diplomacy."

Harry Clary Jones, Ph.D., Baltimore. Professor of Physical Chemistry in Johns Hopkins University. Brilliant investigator of problems connected with physical chemistry. Author of several works on that subject and contributor to American, German and French scientific journals on chemical and physical phenomena.

Leo Loeb, M.D., Philadelphia. Assistant Professor of Experimental Pathology in University of Pennsylvania. Research worker in animal pathology and general pathology. Author of papers on Regeneration and Transplantation of Tissues; Etiology and Growth of Tumors; Coagulation of the Blood and Thrombosis; Venom of Heloderma, etc. One of the Board of Editors of *Folia Hæmatologica;* Collaborator of the *Biochemisches Centralblatt; Zeitschrift für Krebsforschung;* and *Jahresbericht über Immunitätsforschung.*

James McCrea, Ardmore, Pa. Civil Engineer; President of the Pennsylvania Railroad.

Richard Cockburn Maclaurin, F.R.S., LL.D. (Cantab.), Boston, Mass. Formerly Professor of Mathematical Physics in University of Wellington, New Zealand, and of Applied Mathematics in Columbia University, New York. President of the Massachusetts Institute of Technology. Author of many scientific articles of high value. Distinguished for investigations in mathematical physics, especially physical optics, published chiefly in Proceedings of Royal Society.

Benjamin O. Peirce, Ph.D., Cambridge, Mass. Professor of Mathematics and Natural Philosophy in Harvard University. Eminent authority on

mathematical physics and magnetism. Author of "Theory of the Newtonian Potential Function"; "Experiments in Magnetism," and of numerous scientific papers on physics and mathematics. Fellow of the American Academy of Arts and Sciences; Member of the National Academy of Sciences; American Mathematical Society; American Physical Society; Astronomical, and Astrophysical Societies of America, etc.

Harry Fielding Reid, Ph.D., Baltimore. Professor of Geological Physics in Johns Hopkins University, Baltimore. Special agent in charge of earthquake records in U. S. Geological Survey. Professor of Mathematics (1886–89) and of Physics (1889–94) in Case School of Applied Science, Cleveland, Ohio. Author of "Reports on the Highways of Maryland," and of article on glaciers.

James Ford Rhodes, LL.D., Boston, Mass. Historian. Author of "History of the United States from the Compromise of 1850," in seven volumes (1850–77). Recipient of the Loubet Prize of the Berlin Academy of Sciences.

Owen Willams Richardson, M.A. (Cantab.), D.Sc. (Lond.), Princeton, N. J. Professor of Physics in Princeton University. Has published since 1901 important papers on the radioactive discharges from hot bodies. These researches have recently led to the experimental verification of Maxwell's law of distribution, and are still in active progress. His papers have appeared in the Philosophical Transactions and in the London, Edinburgh and Dublin Philosophical Magazine.

FOREIGN RESIDENTS

Adolf von Baeyer, Ph.D., M.D., F.R.S., Münich. Professor of Chemistry in University of Münich since 1875. Fellow of the Royal Society; Member of the National Academy of Sciences, and of the Academies of Berlin, St. Petersburg, Vienna and Rome, and of the Institute of France. Distinguished for his investigations in the field of organic chemistry. Recipient of the Nobel prize in chemistry in 1905 and was awarded the Davy Medal by the Royal Society in 1881 for his researches on indigo.

Madame S. Curie, Paris. Chemist; Discoverer of Polonium, Radium, etc.

Sir David Gill, K.C.B., Sc.D., LL.D., F.R.S., London. H. M. Astronomer at Cape of Good Hope, 1879–1907. President of the Royal Astronomical Society; Past-president of the British Association for the Advancement of Science; Member of the Academies of St. Petersburg, Berlin, Rome, of the Institute of France and of the National Academy of Sciences. In 1877 proposed and carried out an expedition to Ascension Island to determine the solar parallax by observations of Mars. Author of report of this expedition; of Heliometer Determinations of Stellar Parallax in Southern Hemisphere; Determination of the Solar Parallax and Mass of the Moon from Heliometer Observations of Victoria and Sappho; Gold Medallist of the National Academy of Sciences; of the Astronomical Society of the Pacific; and of the Royal Society.

Edward Meyer, Ph.D., LL.D., Berlin. Professor of Ancient History in the University of Berlin. Leading authority on ancient oriental history. Author of "Geschichte des Altertums"; "Forschungen zu Alter Geschichte"; "Die Israeliten und ihre Nachbarstämme"; and of numerous papers and monographs. German Exchange Professor at Harvard University (1909–10).

Charles Émile Picard, Paris. Vice-president of Academy of Sciences of Paris; Professor of Analyse Supérieure in the University of Paris, and of General Mechanics at l'Ecole Centrale des Arts et Manufactures. Member of the Academies of Berlin, St. Petersburg, Rome, Copenhagen, Turin, Bologna, Boston and Washington; Member of the Royal Societies of Göttingen, Upsala and Helsingfors. Author of Traité d'Analyse; Théorie des functions Algébriques de deux Variables and of numerous memoirs upon mathematics.

THE GEORGE WASHINGTON MEMORIAL BUILDING

The council of the American Association for the Advancement of Science, at its meeting in Boston in December, gave its approval to the general plan of the George Washington Memorial Association to erect in the city of Washington a building to serve as a home and gathering place for national, patriotic, scientific, educational, literary and art organizations, including the American Association for the Advancement of Science, and authorized the appointment of a committee of five to assist in the effort.

President Michelson appointed as this committee Dr. C. D. Walcott, secretary of the Smithsonian Institution, Dr. Ira Remsen, president of Johns Hopkins University, Dr. William H. Welch, of the Rockefeller Institute, Dr. George M. Kober, of the George-

town University, and Dr. L. O. Howard, permanent secretary of the American Association for the Advancement of Science.

In late March, this committee sent out an appeal to members urging contributions to aid in the erection of the memorial building. The committee reports that to April 19, contributions had been received to the amount of $4,050. The committee still hopes to receive a considerably larger sum and the general committee of the George Washington Memorial Association is much pleased with the generous and immediate response from the members of the American Association.

SCIENTIFIC NOTES AND NEWS

MEMBERS of the National Academy of Sciences have been elected as follows: Forest Ray Moulton, assistant professor of astronomy in the University of Chicago; William Albert Noyes, professor of chemistry in the University of Illinois; Thomas Burr Osborne, research chemist in the Connecticut Agricultural Experiment Station; Charles Schuchert, professor of paleontology in Yale University; Douglas Houghton Campbell, professor of botany in Stanford University; Jacques Loeb, professor of physiology in the University of California, who will become head of a department in the Rockefeller Institute for Medical Research, and John Dewey, professor of philosophy in Columbia University. Dr. George E. Hale, director of the Mount Wilson Solar Observatory of the Carnegie Institution, has been elected foreign secretary of the academy, to succeed the late Mr. Alexander Agassiz. The Draper medal has been conferred on Dr. C. G. Abbot, director of the Astrophysical Observatory of the Smithsonian Institution.

DR. JOHN TROWBRIDGE, Rumford professor and lecturer on the application of science to the useful arts, at Harvard University, and director of the Jefferson Physical Laboratory, will retire from active service at the close of the present academic year.

DR. LEO LOEB has resigned his position as assistant professor of experimental pathology in the University of Pennsylvania and will take up the directorship of the pathological department of the St. Louis Skin and Cancer Hospital on September 1 of the present year. Dr. Moyer S. Fleisher, of Philadelphia, accompanies him as one of his assistants.

PROFESSOR ROBERT KOCH, who has been seriously ill with pneumonia at Berlin, is now making favorable progress.

DR. BASHFORD DEAN, Columbia University, has lately received a silver cup from the Emperor of Japan in recognition of his services to Japanese zoology.

THE Linnean Society will award the Linnean gold medal to Professor Georg Ossian Sars, professor of zoology in the University of Christiania.

PROFESSOR F. W. PUTNAM, of Harvard University, has been elected a corresponding member of the Societá Romana di Anthropologia, of Rome.

M. CHARLES LALLEMAND has been elected a member of the Paris Academy of Sciences in the section of geography and navigation in the place of the late Bouquet de la Grye.

SIR ERNEST SHACKLETON, the Antarctic explorer, was presented with a gold medal by the Geographical Society of Pennsylvania at a dinner given in his honor at Philadelphia on April 22. Rear Admiral George Melville and Amos Bonsall, a survivor of the Kane Arctic expedition, were among the speakers.

MCGILL UNIVERSITY will confer on Professor Louis A. Herdt, head of the department of electrical engineering, the degree of doctor of science.

DR. M. P. RAVENEL, head of the department of bacteriology of the University of Wisconsin, and of the State Hygienic Laboratory, is a member of the American committee to report at the Second International Congress of Alimentary Hygiene at Brussels, Belgium, October 4, on bacteriological aspects of the hygiene of nutrition.

THE Academy of Natural Sciences of Philadelphia has appointed Professor J. C. Arthur, of Purdue University, a delegate to represent it at the third international Botanical Congress.

WELLESLEY COLLEGE has appointed Professor C. B. Thompson delegate to the international zoological congress at Graz. Miss Thompson will sail for Antwerp on June 25, and will spend the greater part of the summer in Austria.

DR. JAMES R. ANGELL, professor of psychology in the University of Chicago, has left this country for Great Britain.

DR. W. CRAMER, of the physiological department of the University of Edinburgh, is visiting some of the American universities.

MEMORIAL services were held in Sage chapel at Cornell on April 24 for Ross G. Marvin, who lost his life on the Peary expedition. Commander Peary delivered the memorial address, dedicating a tablet which has been erected in the chapel to Professor Marvin's memory. President Jacob Gould Schurman read a biographical sketch, written by Professor O. M. Leland, a member of the faculty of the College of Civil Engineering, to which Professor Marvin belonged.

THE death is announced of M. Charlois, of the Nice Observatory, known especially for his work on the minor planets.

MR. C. BIRD, headmaster of the Rochester Mathematical School and the author of textbooks on geography and geology, died on April 11, aged sixty-seven years.

THE senate committee has given its approval to a proposed amendment to the sundry civil bill providing for the establishment of a seismological laboratory in connection with the Smithsonian Institution. The proposed annual appropriation is $20,000.

A JOINT meeting of the American Society of Mechanical Engineers with the Institution of Mechanical Engineers will be held this summer in Birmingham and London, beginning on July 26.

WE learn from *Nature* that in connection with the aviation week to be held at Verona in the first fortnight of May, it is proposed to organize a first International Congress on Aerial Locomotion. On the scientific side the movement has received the support of Professors Angelo Battelli (Pisa), Giovanni Celoria (Brera Observatory), Giuseppe Colombo (Milan), Count Almerigo di Schio, Dr. Enrico Forlanini, Professor Luigi Palazzo, Professor Righi (Bologna), Professor Vito Volterra (Rome).

A preliminary program has been issued for this year's meeting of the British Association, which is to take place at Sheffield on August 31 and following days. The president, the Rev. Professor T. G. Bonney, will have the assistance of representatives of the municipal, educational, ecclesiastical and commercial activities of the city, who have been appointed as vice-presidents for the meeting, headed by the Lord Mayor, the Rt. Hon. Earl Fitzwilliam. To the list of sections, whose presidents have already been announced, there has been added, as in previous years, a sub-section of agriculture, which this year will be formed under the section of chemistry, with Mr. A. D. Hall, F.R.S., as chairman. The conference of Delegates of Corresponding Societies will assemble this year as usual, at Sheffield, during the meeting, and not in London, as last year, when the meeting was in Canada. Its chairman will be Dr. Tempest Anderson. The reception room and administrative offices during the meeting will be established in the Cutlers' Hall. It is centrally situated, and a great majority of the sectional meeting-rooms will be within a very short distance of it. The Victoria Hall will be the scene of the opening meeting on Wednesday evening, August 31, when Professor Bonney will deliver his inaugural address. In the same hall the first evening discourse will be delivered on the Friday evening by Professor William Stirling on "Types of Animal Movement," and the second on the Monday evening by Mr. D. G. Hogarth on "New Discoveries about the Hittites." Receptions are announced to be given by the lord mayor and by the university, and a number of garden parties will be arranged. The city itself and its vicinity offer a wide range of scientific interests, as for example to chemists and metallurgists, geologists, and students of economic and educational problems, while its close proximity to the Peak district, the "Duker-

ies" and other interesting localities affords many opportunities for relaxation.

Owing to the delay in the issuance of the second circular of the Eighth International Zoological Congress, at Graz, the president requests us to call the attention of the American members to the following points. Apparently all the state railways of Austria as well as the "Südbahn" will allow a very material reduction in the price of tickets, upon the exhibition of membership or participant's cards as soon as the Austrian frontier is crossed. It is therefore best for all to have these cards before entering Austria and prospective members should send their remittance (members 25 Kronen, participants 12 Kronen—a Krone is a little more than 20 cents) to the "account of the VIII. International Zoological Congress" at the Steiermärkische Escomptebank in Graz. All applications for accommodations should be addressed to the Præsidium des VIII. Internationalen Zoologenkongress, Universitätsplatz 2, Graz, Austria, and should specify the number of rooms, beds, price desired, the day, and where possible the hour of arrival in Graz. The hotel accommodations of the city are rather limited and it is probable that students' rooms will have to be used, this involving getting the meals in another place. It is expected that the English edition of the second circular will be issued about the first of May.

Graduate students in geology from the University of Wisconsin are spending the month of May in detailed mapping of the pre-Cambrian rocks of the Menominee iron-bearing district of Michigan. Professor C. K. Leith and Mr. W. J. Mead are in charge of the party. This work constitutes a regular course in geology at the University of Wisconsin.

The first meeting of New York state teachers of educational psychology was held at Ithaca, April 8 and 9, at the invitation of the Educational Department of Cornell University. Representatives of the college and normal schools of the state discussed the extent and form of instruction in the nervous system, and the place of experimental work, in the course in educational psychology. The latter discussion resulted in the formulation of the chief purposes for which experimental work might be introduced, and of the criteria for the selection of specific experiments. The discussion of experimental work was supplemented by an exhibition of the apparatus used for demonstration in the Cornell course in general psychology, of the drill and research equipment of the psychological laboratory, and of apparatus in the educational laboratory for the conduct of mental tests. By invitation, the evening meeting was held in the psychological laboratory, where the formal program was followed by an exposition by Professor Titchener of the contributions of the Cornell laboratory to structural psychology, with special reference to the experimental psychology of the thought-processes. A committee consisting of Professor G. M. Whipple, of Cornell (chairman), Professor George M. Forbes, of Rochester, Dr. W. Van Dyke Bingham, of Columbia, and Dr. Susan F. Chase, of the Buffalo Normal School, was appointed to arrange for a meeting next year.

Provision has been made for instruction and field work in botany, zoology and geography at the Illinois Biological Station recently established on Quiver Lake, an offset of the Illinois River one and a fourth miles above Havana in Mason County, Illinois. The students will have as the field of their observations, the banks of the Illinois River itself, a series of lakes, streams and bayous of the vicinity, and the bottoms, bluffs and uplands adjacent, which present a great variety of situations unusually rich in all plant and animal forms. All students will have the use of the Chautauqua grounds of the State Association of Epworth Leagues. Sleeping and dining rooms, laboratories and a lecture room are thus provided, ready for use. The grounds are on a forest-covered, somewhat sandy, elevated bank or bluff, bordering Quiver Lake, are lighted by electricity and are abundantly supplied with pure water. The session will begin June 20 and continue six weeks.

THE New York Botanical Garden has arranged spring lectures to be delivered in the lecture hall of the museum building of the garden, Bronx Park, on Saturday afternoons, at four o'clock, as follows:

April 30—"Spring Flowers," Dr. N. L. Britton.

May 7—"Collecting in Southern Mexico," Dr. W. A. Murrill.

May 14—"The Origin and Formation of Coal," Dr. Arthur Hollick.

May 21—"Water Lilies," Mr. George V. Nash.

May 28—"An Expedition to the Panama Canal Zone," Dr. M. A. Howe.

June 4—"Summer Flowers," Dr. N. L. Britton.

June 11—"The Rose and its History," Mr. George V. Nash.

June 18—"The Native Trees of the Hudson Valley," Mr. Norman Taylor.

June 25—"The Extinct Flora of New York City and Vicinity," Dr. Arthur Hollick.

July 2—"The Fungous Diseases of Shade Trees," Dr. W. A. Murrill.

THE Third International Physiotherapeutic Congress was inaugurated by President Fallières in the courtyard of the School of Medicine at Paris, on March 29. The London *Times* states that a large number of members of the French government and the diplomatic corps in Paris, including the British and American ambassadors, were present at the ceremony. M. Fallières in his address declared that all questions relating to the public health were the intimate concern of every government. He spoke of the advance of medical science in having established the fact that some diseases which were the great scourges of humanity could no longer be regarded as "inevitable," and he ventured to look forward to the day when by the aid of medical science these diseases would be actually eliminated. He also felt that the medical profession was justified in its hope of a future population which would be better adapted physically for the struggle of modern life in the office and in the workshop.

UNIVERSITY AND EDUCATIONAL NEWS

ASSEMBLYMAN WHITNEY'S bill to establish a state school of sanitary science and public health at Cornell University, and to appropriate $10,000 toward its maintenance, has passed the New York assembly.

THE mining engineering building of the University of Wisconsin, formerly the old heating plant, has been entirely rearranged for its new purposes, and is nearing completion, much of the equipment of modern mining machinery having already arrived, and the laboratories will soon be in readiness for research and instruction.

DR. A. STANLEY MCKENZIE, professor of physics at Dalhousie University, and previously at Bryn Mawr College, has accepted a chair of physics at the Stevens Institute of Technology.

DR. CHARLES A. KOFOID, associate professor of histology and embryology in the University of California, has been appointed professor of zoology in that institution.

MR. HENRY HOMAN JEFFCOTT, head of the meteorology department of the British National Physical Laboratory, has been appointed to the chair of engineering in the Royal College of Science for Ireland.

DISCUSSION AND CORRESPONDENCE

THE PLANET MARS

TO THE EDITOR OF SCIENCE: I should very much like to urge the importance of the suggestion made by Professor R. G. Aitken in the issue of SCIENCE for January 21, 1910, that Mr. Percival Lowell invite a committee of *recognized experts* in planetary observation, to go to Flagstaff and with him to observe the planet Mars (and if possible Venus and Mercury also).

I find here in South America just as keen an interest by the public in the real state of our knowledge as to Mars, as anywhere in the world, and am sure that no greater service could be rendered to astronomical science from the standpoint of the intelligent public, than to settle some of the many open questions relating to the surface markings of Mars.

As Professor Aitken points out, "doctors disagree" in this matter and to such an ex-

tent that the average man knows not what to believe, he sees so many contradictory statements, drawings and photographs.

It need hardly be pointed out that little real progress can be made in any branch of scientific work until the fundamental points are placed on a much more secure foundation than are many of the most important details regarding Mars.

It would seem that the best way of finally settling some of these matters would be, as suggested by Professor Aitken, to have them passed upon by a committee of experts of such well-recognized standing as to make their unanimous verdict final and acceptable to all scientific men.

Then, and not until then, will these questions of the surface markings of Mars be upon a dependable basis.

It is also pertinent to point out the saving of time which will result in many ways and to many people by having a sure foundation in this matter.

The financing of such a project should not be at all difficult considering the general interest which attaches to Mars.

C. D. Perrine

KIRCHER AND THE GERM THEORY OF DISEASE

It would appear from Dr. Garrison's article on "Fracastorius, Athanasius Kircher and the Germ Theory of Disease,"[1] that I am in the usual plight of one who attempts to fix credit for the early suggestion of a scientific theory. Apparently there is always to be found some one who had thought it all out long in advance of—the next man. But though I have no desire to play the rôle of special pleader for Athanasius Kircher, it is only fair to point out that Dr. Garrison does this early investigator an injustice when he says that "Neither Kircher nor Leeuwenhoek could have seen bacteria of any kind with the lenses at their command. . . . His [Kircher's] glass or microscope was only 32 power at best."

Aside from Kircher's apparently loose statement that one of his microscopes showed objects "a thousand times larger," we have no direct data regarding the magnifying power of his lenses. We do know that the simple microscopes of his and Leeuwenhoek's time possessed great magnifying power and that by their use many structures were studied which at present we should not think of examining without a compound microscope. We know, too, that of the several microscopes described or figured by Kircher, one type was fully comparable to those of Leeuwenhoek and, fortunately, concerning the latter we have very full and definite information. One of the Leeuwenhoek microscopes still extant and described by Harting, had a magnifying power of 67 diameters. The twenty-six microscopes presented to the Royal Society of London, by Leeuwenhoek, varied in magnifying power from 40 to 160 diameters. The maximum power of those known is possessed by one still preserved in the Museum at Utrecht, which magnifies 270 diameters.

In the face of these facts and Leeuwenhoek's detailed description of, for instance, the organisms found in scrapings from the teeth, it hardly needs the additional evidence of his illustrations to prove that this worker really saw bacteria. No one believes that Kircher anticipated by some two hundred and fifty years Yersin's and Kitasato's discovery of the bacillus in the blood of plague patients, but I still believe that "There is no doubt that long before Leeuwenhoek's discovery, Kircher had seen the larger species of bacteria" in putrid broth, milk and the like. Imperfect and faulty as his observations must have been, he had definite observation as a basis for his theory of the animate nature of contagion. Certainly, his conception of the rôle of flies in the transmission of disease marked an advance over the theory of Mercurialis.

William A. Riley

[1] Science, April 1.

KAHLENBERG'S CHEMISTRY

To the Editor of Science: Inasmuch as possibly a large majority of teachers of first-year college students will agree with Dr. Hopkins in his criticism[1] of Lewis's review of

[1] Science, N. S., XXXI., p. 539.

Kahlenberg's "Chemistry," I feel impelled, as one who has had considerable experience in teaching first-year students, to express my hearty agreement with the points made by Dr. Lewis. Let me say, to begin with, that it is not improbable the teacher who deals with the finished product of the one who has done the "first-year teaching" is better capable of judging the success of that teaching than the first-year teacher himself. I have been inclined to judge my own work by the way my students have been able to handle advanced work, rather than by their success with the first-year's work itself. I therefore believe the teacher of advanced students is the most competent critic of elementary work, and that Dr. Lewis is in the best possible position to judge of methods of laying foundations in chemistry.

The more important question at issue, however, which is squarely met by author, reviewer and critic, is whether we shall present the conceptions of modern physical chemistry to first-year students. And it should be remembered that this is not the question of the truth of a theory of electrolytic dissociation, but whether such conceptions as electrolytic dissociation, equilibrium and its disturbance, mass-action, phase-rule and others, which have furnished at least the best working hypotheses for the superstructure of modern chemistry, not merely theoretical, but industrial, shall be *used as fundamental conceptions,* for the first-year, second-year and every other year students; or shall be simply introduced in one or two chapters, apart from all the rest of the subject, as in Kahlenberg's book; or perhaps not mentioned at all in elementary chemistry, being left for some future time, should the student conclude to further pursue the branch. The two chapters in Kahlenberg's book which take up these conceptions might be absolutely omitted without injury to the rest of the book, as far as anything in the rest depends upon these two chapters. Many other older chemistries have been "brought down to date" by adding or inserting new chapters on these so-called modern conceptions. Is it not a little as if one were to modernize a medieval work on astronomy by adding a chapter on the work of Copernicus? Is it not a rather sad commentary on the chemical teaching of to-day when a professor in one of our leading and progressive colleges pleads for the "chemistry of a generation or more ago"? With no intent at irreverence, I can not refrain from quoting the lines that come to my mind from the old hymn,

> 'Twas good enough for father,
> 'Twas good enough for mother,
> 'Tis good enough for me.

Seriously, Kahlenberg's book represents probably the high-water mark of the older chemistry, and especially in presenting "just what the beginner wants to know in the way he wants to have it presented," but is it the neophyte who should be consulted regarding what he is to be taught? In my own case it has been far from an easy task to assimilate the fundamental conceptions of modern chemistry, and I do not desire that any student who goes out from my class-room shall be under the necessity of a complete mental revolution should he pursue the subject farther. It is better, even for the beginner, to study a smaller number of reactions as illustrative of fundamental laws than to make himself master of the great mass of facts of descriptive chemistry with which many of our text-books are filled. Elementary science seems ever to be the last to be influenced by great discoveries and generalizations. Only within the last decade or so have the elementary text-books on the biological sciences been appreciably influenced by the work of Darwin, so we need not be surprised if we find little evidence, even in many of our college text-books of chemistry, of the revolutions in chemical thought wrought by such men as Arrhenius, and Guldberg and Waage, and Mendeleeff, and Gibbs, and others, whose work has been before the world of chemistry for more than a quarter of a century.

JAS. LEWIS HOWE

WASHINGTON AND LEE UNIVERSITY

April 12, 1910

SCIENTIFIC BOOKS

MAGNETIC WORK OF THE BRITISH NATIONAL ANTARCTIC EXPEDITION OF 1901–4

THUS far three volumes of results in geophysics have been published by the Royal Society of the fruitful Antarctic expedition under the command of Commander R. F. Scott, R.N.: Meteorology (Part I., Observations at Winter Quarters and on Sledge Journeys, with discussions by various authors); Physical Observations (tidal, gravity, seismic, auroral and ocean magnetic observations), and just recently the volume "Magnetic Observations." We shall confine our attention to the magnetic work and especially to the last volume.

In the Report on the "Physical Observations," Commander L. W. P. Chetwynd, R.N., superintendent of the Compass Department of the British Admiralty, published and discussed the results of the magnetic observations made on board the *Discovery* during her cruise, as also those obtained on land. From the various sledge journeys, he deduced for the position of the south magnetic pole in 1903, as derived from the magnetic declination results, 72° 50′ S. and 156° 20′ E.; from the observations for magnetic dip, 72° 52′ S., 156° 30′ E., hence, average position 72° 51′ S., 156° 25′ E. While these two positions agree closely, it must be stated that neither depends upon observations made at or in the vicinity of the south magnetic pole, but upon more or less complete observations some distance away. The same is to be said of the position determined by the highly successful Shackleton expedition in the beginning of 1909, viz., 72° 25′ S. and 155° 16′ E.—forty miles distant of the 1903 position; the observer (Douglas Mawson) had not quite observed a dip of 90°. Were it sufficiently important, much more elaborate observations would be required than any made by the expeditions thus far; it is, accordingly, not possible to say whether the difference between the positions for the two expeditions actually represents the secular change between 1903 and 1909.

The *Discovery* being not strictly a non-magnetic vessel, the reduction of the magnetic observations on board must have presented at times difficulties. Only results for declination and dip are published—no force observations being given, though the instrumental appliances admitted also of such work.

Auroral observations were taken chiefly by the officer of the watch whenever there were displays, the physicist and chief magnetic observer, Mr. L. C. Bernacchi, supplementing the observations on special occasions. There are worked out diurnal and monthly periodic variations, change of direction of display during simultaneous appearances with aurora borealis, sun-spots and magnetic disturbances.

The volume on "Magnetic Observations" is devoted to a discussion by the superintendent of the Kew Observatory, viz., Dr. C. Chree, F.R.S., of the magnetic observatory observations made at the *Discovery's* "Winter Quarters," May, 1902, to January, 1904, in McMurdo Sound, latitude 77° 50′.8 S. and longitude 166° 44′.8 E. The magnetograph was of the German (Eschenhagen) portable type, the absolute instruments consisting of Kew pattern magnetometers and Dover dip circles. An entirely satisfactory site for the observatory could not be obtained because of the prevalence of local magnetic disturbances due to the basic volcanic rocks consisting particularly of basalt, containing grains of magnetite; observations for standardization purposes were accordingly made out on the ice over the deep sea.

The arduous duties of observer-in-charge were performed by Mr. Bernacchi, who also assisted Dr. Chree in the reductions and discussions of the data and preparation of the results for publication. There are added at the end of the volume various reproductions of the magnetograms of special interest not only as obtained by the *Discovery's* observatory, but also at the cooperating stations: Kew, Falmouth, Mauritius, Colaba and Christchurch.

In addition to the usual tables of hourly values of the magnetic elements, of the daily, the annual and of the secular variations, and results of related analyses, Chree opportunely devotes considerable space to a discussion of magnetic disturbances of various types. In

Appendix B he furthermore makes an examination of Antarctic disturbances from October, 1902, to March, 1903, simultaneous with those discussed by Professor Kr. Birkeland in Vol. I. of "The Norwegian Aurora Polaris Expedition 1902–3." While he finds correspondences, his examination also discloses certain disagreements from the effects predicted by Birkeland, thus showing the directions in which the latter's theory requires amplification.

It is a pity that a work of such importance as the volume before us should not be better indexed or at least better arranged so that one could readily turn to any desired topic. A more liberal introduction of subsections, subdivisions, etc., would have been helpful. In the mathematical analysis it might have been better also to have followed a notation now commonly in use.

L. A. BAUER

Traité de Géographie Physique. Par E. DE MARTONNE. Paris, Armand Colin. 1909.

The present book is divided into five main parts: Notions générales, Climat, Hydrographie, Relief du Sol and Biogéographie. The reviewer does not propose to discuss the whole voluminous work, but restricts himself to the last part, the biogeographical, and a special chapter (chapter VIII.) of the fourth, namely, that on paleogeography.

A general treatise on biogeography is a hazardous undertaking at the present time; the science of the geographical distribution of the life upon the earth has undergone, during the last two decennia, such a revolution, and is still progressing at such a rapid rate, with much to be yet investigated, that we can not expect to be able to obtain a general view of the present state of our knowledge, which could be embodied as something final in a text-book.

M. de Martonne has fully realized this fact, and has avoided certain difficulties with great skill. In fact, he does not give a complete treatise of the science of biogeography according to the pattern, as laid down, for instance, by Wallace, and his book is by no means a compendium of distributional facts brought into a more or less satisfactory scheme; instead of this, he gives the general principles and laws, which govern the distribution of organisms, drawing from these the inferences with regard to the different groups of the latter, and illustrating them by selected examples.

Thus his treatment of biogeography is chiefly an account of the relations of the organic world to the physical conditions prevailing upon the earth, and might be called a general "Ecology." Three of the chapters (I., II. and IV.) are principally devoted to this side. For the rest, he discusses the distribution of plants and animals from this standpoint, dividing them into ecological classes, for which he gives the distribution upon the earth. He avoids by this, for instance by treating the different marine and terrestrial groups of animals separately, the difficulty of the association of creatures with different "habitats" into one scheme, which was the chief stumbling block of the older zoogeographers.

A very good illustration of the consequences of the author's method is seen in the map he gives for the distribution of the continental faunas (Fig. 390, on p. 852). This map differs greatly from the usual maps given for the distribution of land animals, but it is very well to keep in mind that it is not intended to represent the actual distribution of any animal, but is drawn to express, so to speak, the *possibilities of animal distribution* with relation to the distribution of the factors controlling the various types of animal life, in fact, it is an *ecological map of the continents.* For the reality of the divisions laid down upon this map examples are introduced, but, of course, only a limited space could be reserved for them.

The author insists that these relations of the organic world to their environment are of prime importance for the distribution of life upon the earth, and in this he certainly is right. But he also admits that the geographic history of the earth plays an essential part in this question. *The historical develop-*

ment of the present distribution of plants and animals, which is one of the most fascinating problems of recent biogeography, is not neglected by him. But he does not approach it from the biogeographical standpoint in so far, as he does not attempt to prove former geographical conditions by the present distribution of any organic forms, but makes it a part (chapter VIII., p. 577 ff.) of the physical geography of the land, and treats of it in connection with geological principles. His general account of the history of the continents and oceans, although given only in its main features, is rather good, and deserves attention. It rests chiefly upon the studies of the most prominent writers in this line (Suess, Lapparent, Frech, etc.).

Altogether we may say that the parts of this book discussed here are well worth reading. Difficult branches of scientific research, which are yet subject to much controversy, are represented in a lucid way, showing the cleverness and originality of the writer, and demonstrating also that he is well acquainted with the most modern phases of the questions discussed. It is hardly feasible to go into any detail, and to attempt a critical review of the special opinions of M. de Martonne, since in certain cases we would be compelled to offer evidence for the contrary, for which there is no room in these pages. We only would recommend this book to the study of all those who are interested in biogeography, ecology and paleogeography, and we have no doubt it will be a stimulus to them in their own work. These chapters are not so much a "text-book" for the beginner, giving a circumscribed amount of scientific facts to be stored away in the brain, and to be used at an "examination," but they are a challenge to the active, progressive worker in these lines, to scrutinize his own ideas, to revise them, and if they differ from those proposed here, to say so, and to bring forth the evidence, in order that they may be discussed according to their merits.

A. E. Ortmann

Pittsburgh,
March, 1910

Die Chemische Industrie. By G. Müller. Pp. 488. Leipzig, B. G. Teubner. 1909. Price, bound, M. 12.

This book aims to aid the merchant in his calling and to serve as a guide in trade and technical matters for chemists and others engaged in the chemical industries.

The strictly chemical aspects of the subjects here discussed are relegated to another volume, "Chemical Technics" by Dr. Heusler, which has appeared in this same Teubner "Series of Trades and Industries," to which the work here considered belongs.

The author has divided his book into two parts.

Part I. is devoted to the General Survey of Chemical Industry, and includes a discussion of its scientific and technical evolution and of the laws of trade and commerce.

In Part II. the writer takes up individually many of the more important branches of Chemical Industry, among them acids, salts and alkalies, artificial fertilizers, explosives, aluminum compounds, mineral oils, dry distillation, the industries of coloring matters and colors, fats, oils, rubber and gutta-percha; a bibliography of German publications of technical hand- and text-books, a list of some technical journals, and a carefully prepared subject-index, conclude the volume.

A liberal introduction of tables of export and import of many of the chemical substances discussed permit an interesting study of the conditions of various trades in different countries, and at different times. Naturally, German conditions receive by far the largest share of attention, but it can not be said that the trade conditions of other countries have been neglected.

The different topics of child labor, working men's insurance, laws and regulations of hygiene in different industries, all receive consideration and the treatment of the various topics throughout shows an intimate acquaintance with the data and statistics of the subjects discussed.

The statistics generally include those of the year 1907, and are thus well up to date. Prices,

when they are quoted, seem to be given with scrupulous care, in illustration of which it may be remarked that the author quotes the price paid for matches in the United States per thousand, not boxed, and per gross of boxes containing 100 matches each.

The style in which the book is written is pleasant and lucid and, in general, the sense of proportion is well maintained. It does, however, seem strange that no mention whatever should have been made of the Sugar Industry, certainly one of the leading industries of the present day, when the author has found it desirable to refer to the industry of condensed gases, and to that of calcium carbide and acetylene gas, in some detail.

The paper and print are of the usual excellence of the Teubner publications.

F. G. WIECHMANN

Schoenichen-Kalberlah. B. Eyferth's Einfachste Lebensformen des Tier- und Pflanzenreiches. Naturgeschichte der mikroskopischen Süsswasserbewohner. Vierte, vielfach verbesserte und erweiterte Auflage von Dr. WALTHER SCHOENICHEN. Mit über 700 Abbildungen auf 16 Tafeln in Lichtdruck nach Zeichnungen von Dr. A. KALBERLAH. Zahlreichen Abbildungen im Text und 2 Portraits. Braunschweig, Verlag von B. Goeritz. 1909. M. 23.60.

The fourth edition of Eyferth's "Einfachste Lebensformen" from the hands of Dr. Schoenichen brings up to date this old favorite of the amateur microscopist. The work is, however, somewhat more than a popular treatise on the microscopic life of fresh water, being a carefully worked out systematic manual of about 1,700 species. It covers the minute plant life quite completely and includes the Protozoa, Rotifera and Gastrotricha on the animal side. It is to be regretted, in the matter of completeness, that the remaining animal groups of fresh water, at least the Entomostraca, Nematoda, Annelida and Turbellaria, were not added in this revision. Such additions would very greatly enhance the usefulness of the work and might still permit its compass in a single volume. The excellent heliotype plates with their 700 figures from original sources such as Cohn, Fischer, Naegeli, Kirchner, Hansgirg, Rabenhorst, Wille, Van Huerck, Smith, Leidy, Schulze, Penard, Senn, Stein, Klebs, Schewiakoff, Hudson and Gosse and Weber afford a wealth and range of illustration rarely attained in inexpensive manuals. The great reduction in size has resulted in some loss of detail in the case of the plates of the Ciliata, but on the whole it has been adequately preserved elsewhere.

The fourth edition has been enlarged by a complete revision of the Chlorophyceæ, Mastigophora and Rhizopoda and many minor additions in other groups involving the insertion of a considerable number of text figures.

The introductory chapter deals with the œcology of the microscopic life of fresh water, its occurrence and distribution, methods of collection, examination and preservation, and the biological examination of potable waters. The last topic is, however, very inadequately treated, judged by the criteria of the sanitary engineer.

A few errors are to be found in the book; *e. g.*, the genus *Pleodorina* should be assigned to Shaw, and the plates of *Ceratium* are incorrectly described and figured.

There are also some noticeable omissions in the references to important literature, as, for example, the failure to mention the *Archiv for Protistenkunde* and under algæ the omission of West's "Desmids," Penard's "Dinoflagellata," of Chodat's and of Lemmermann's compendiums of Swiss and Brandenburg algæ. Sand's monograph of the Suctoria is not noted. No reference is made to Rousselet's methods for rotifers nor of Jennings's indispensable contributions to the more difficult families of this group.

The index is ample and accurate and the various organisms are, in part at least, classified here by a set of symbols according to their associations and œcological relations as polysaprobs, strong or weak mesosaprobs and oligosaprobs, after the conclusions of Kolkwitz and Marsson.

The book is a useful addition to the library of the laboratory, the water analyst and the amateur microscopist. CHARLES A. KOFOID

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Habit-Formation and the Science of Education. By STUART H. ROWE, Head of the Department of Psychology and Principles of Education in the Brooklyn Training School for Teachers, and Lecturer on Educational Psychology in Adelphi College, Brooklyn, New York. Pp. xvii + 300. New York, Longmans, Green & Co. 1909.

Educational doctrines, so far as they find expression in school practise, have been unseemly erratic. This is due to the fact that the scientific method has never been employed in solving school problems. Education is still an art, managed pretty successfully by those whose instincts are adapted to it, but wretchedly bungled by all others. The schools, like other social institutions, have followed the line of least resistance. During the colonial period, when the body of knowledge was comparatively small, when books were few, and society less complex, children were thoroughly drilled in the few subjects which they studied. With the rapid growth in knowledge and in the industries, during the latter part of the nineteenth century, new demands were made upon the schools. The three R's no longer met the social needs, and, with the enlargement of the curriculum, the drill master disappeared. The unscientific feature in this change is the entire absence of accurate analysis of the problem. A method that has been followed is not necessarily bad because of its age, nor is the new, because of its youth, good. It is this uncritical, mad dash from one method to another, during a time of prevailing scientific investigation, that has brought education into disrepute. Any book, therefore, that critically examines one of the educational problems, is a contribution to education. And this is what Rowe's "Habit-Formation" does. The teacher, Rowe maintains, interferes too much in the learning process of her pupils. She neglects "all the automatic (both natural and acquired) ways of learning which the child has, and insists that he work out everything systematically and under guidance." This is not only a useless waste of teaching energy, but, in addition, it disturbs the course of development. Every child has his own way of responding to his environment, because of his organic structure, and forced departure from this individual mode of reacting must be decided upon only after the most careful examination of the situation. Motor, visual and auditory minded children illustrate the need of care. Rowe discusses the manner in which experience is organized, and emphasizes the distinction between habits and ideas. "Determine whether the habit is an automatism which will be hit upon by the child as a result of his own initiative and experimental efforts, or implies a definite idea which must first appear in consciousness before it can be transformed into a fixed automatic process." In other words, the teacher is to adapt herself to the situation. She is to "analyze the subject-matter and determine what elements in it are to become habitual." The way in which habits are established, the manner of securing practise, and the method of evoking initiative, are treated in separate chapters. Initiative is to be developed through appeals to the instinctive activities, the emotions, and to specialized motives. Appeals to the child's reason are appeals *through* reason to his instincts, emotions or motives. Practise is to be secured by making "all the conditions such that the reaction will take place as naturally as possible." Teachers have been too willing to work against the resistance of the instincts and emotions. This is because, at the outset, it is the line of least resistance, and failure to analyze the situation causes them to overlook the fact that later it becomes the line of greatest resistance. One of the purposes of education is to establish mental attitudes toward the various subjects of study and toward work in general, and Rowe deals at length with the various kinds of drill in relation to this purpose. The difficulty with the book for teachers who are unskilled in psychology is that it lacks concreteness. Illustrative examples are not as numerous as they should be, but this is a less serious objection

than it would have been a few years ago, and altogether the book is a valuable contribution to the science of education. A useful bibliography is appended.

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NOTES ON THE TEACHING OF ZOOLOGY AND PLANS FOR ITS IMPROVEMENT

Few Elect Zoology.—Although for some time the writer has been under the impression that a good many more students elect botany than zoology, both in the high schools and academies and in the college; yet in glancing over our (Kansas) "High School Manual"[1] I was somewhat surprised to find that almost *eight* times as many high school pupils were last year enrolled in botany as in zoology—to be exact, 2,669 in botany and 346 in zoology. Another table in this manual reveals the fact that while 177 of the accredited high schools claim to be equipped for botany, but 33 claim any equipment for zoology, and the latter is usually estimated at a lesser value. I can quote figures from one other state only. In Minnesota,[2] starting with a ratio of 4 to 1 in 1894, zoology has steadily gained till last year it stood 9 to 7 in favor of botany. The fact that neither St. Louis, Mo., nor Tacoma, Wash., offers any zoology in its high schools leads me to suspect that similar disproportion exists in other states, at least in the middle and far west.

We teachers of zoology can not avoid asking, Why is this so? It is surely not because animals with their free movements and their intelligence are less interesting than plants. Where is the child or grown-up (aside from the specialist) who will not leave the prettiest bed of flowers to watch the cage of playful monkeys? The moving object, particularly the automatically moving one, attracts all of us. Nor can it be that the school authorities regard zoology as less practical than botany. To know the ravaging insect is just as important as to recognize the medicinal plant. To name the brilliant song bird properly is just as desirable as to classify the fragrant flower.

According to my thinking, at least three causes can be cited which operate to bring about such a disproportion between the subjects.

The first one is the lack of properly prepared teachers. Few of the instructors in the high schools are prepared to teach either of the two sciences. When called upon to teach one, a majority will choose botany instead of zoology. They probably had a course in elementary botany and not in zoology. Besides, plants are simpler and they feel that they can manage a course concerning them better than the more complex and larger group of animals.

A second and probably a more potent cause is the fact that many of our children are taught by their parents from early childhood to avoid and fear the animals—the creepy worms, the biting spiders and the dreadful mice. In "nature study" in the grade schools (taught by women) this view of the animals is farther inculcated. As a result, when the young people get into the high school and are to select a biological science they naturally choose botany.

The third cause is a greater one, at least a more real one. It is the difficulty of securing plenty of good material for the course in zoology. While the botanist has all his important phyla represented in almost any inland region, the zoologist has three important phyla practically limited to salt water. This necessitates the securing of a good deal of material from the seashore. And of the material that is in the vicinity it is so much easier for the botanist to secure what he wants—to pick the flower on the bank of the brook than to catch the cray-fish in the dirty water. The flower will surely be found on the first "tramp," provided it is made at the right time and to the right place. To secure the cray-fish, in addition to choosing the right season and the proper locality, the necessary seine or other paraphernalia to catch the desired specimen must be taken along. Sometimes it means the employment of help to handle the apparatus. To secure some species requires a different set of tools, and they are even harder to get than

[1] *Bulletin of the University of Kansas*, 1908.

[2] Fifteenth Annual Report of the Inspector of the State High Schools. State of Minnesota, 1908.

the cray-fish. After the material has been brought to the laboratory it needs to be killed and preserved by proper methods. All this means more trouble than the ordinary high-school teacher wants to or has time to take.

It is true some specimens can be bought; and matters are rapidly improving as more collectors are selling zoological supplies; yet not all the things needed are on the market. Many of those who would teach zoology do not know where to buy. The cost, which is considerable, hinders some. Besides, teachers feel that a good many local forms should be studied, and this is true especially in the high school. But where and how shall they be secured?

University a Distributing Center.—To answer the last question and encourage zoology teaching over the state the department of zoology in the University of Kansas has decided to become a central supply station for the secondary schools of the state. Many of the standard type-forms have been purchased in larger quantities than needed for the department's own use. A good deal of local collecting has been done; besides, two expeditions have been taken, one to the Gulf Coast in 1908, and one to Puget Sound in 1909. On both of these trips, but especially the latter, large quantities of material were secured for class use. This has been carefully prepared and preserved for dissection and demonstration. All these collections put the department in shape to supply all the necessary material to the secondary schools. A preliminary list of what can be furnished has been sent to the schools. Prices are very low, because of the excellent collecting found on the coast of Puget Sound, and because the plan of the department is not to make money out of the venture, but to get more zoology taught. So as not to discourage small schools, small orders are sold at nearly as low prices as larger ones. The result of the whole plan is and will continue to be to encourage and improve greatly the zoology teaching in our preparatory schools.

"Problem Solving."—The writer believes that one important thing in teaching is to get the student to "solving problems." Professor Alexander Smith has recently emphasized this very much in the columns of this JOURNAL.[3] With this in view the writer has for five years assigned to every member of the classes in the second and third courses in zoology one major problem to be worked out and reported on before the class. The question to be reported on was always so chosen that it could not be answered from any book, but required independent dissection and observation. The subject was assigned early in the semester so that the student had ample time to work it out in addition to the daily work in the class room. This has always given satisfactory results.

During the last two years our department has used in elementary zoology such a scheme of "problem solving" that seems to me to be worthy of a trial by other teachers. Our elementary classes are large, running from 75 to 100 or more students. After the type form for the phylum or class is done other species of the group are classified by the student as far as the order. For this purpose we have regular sets of bottled and numbered specimens which are given to a small section of the class and these students classify them, giving the reason for, or the characteristic used in, every determination. Similar sets are being prepared for the high schools, either to be sold or loaned to them.

After all the principal phyla have been studied every student, as far as possible, is given a different animal. He finds out what the specimen is, dissects it, makes drawings of it and in short finds out all he can about it, and then reports his findings to the rest of the class. As most of these specimens are but briefly if at all described in the usual texts used, the problem is a real one to the student. He is urged and must of necessity get first-hand knowledge by comparing his specimen with the forms already studied. Only after he has found all he can is he guided to additional literature. By this plan the student solves a real problem. He learns to notice in a new way how the "types" are treated in the text-books so as to get a plan for the arrangement of his own material. This plan must be approved by one of the instructors before the report can be given to the class. While one stu-

[3] SCIENCE, N. S., XXX., p. 459.

dent reports the rest take notes, just as they do when the instructor lectures. At the end of each report questions are asked and corrections are made. The notes taken by the rest of the students are corrected by the one who gives the report, and are bound up with the students' general note-book for the course. The one reporting binds up his outline, and a list of the books and papers consulted—a bibliography.

By this plan the student learns much about one animal not treated in the texts and he learns a little about a good many other species. But he does more—*he gets a training in using the powers of observation, in ordering the facts obtained and in expressing to others the knowledge gained.*

The two main suggestions are worth a trial by other teachers. The university should encourage the teaching of zoology by becoming a center for furnishing and distributing the material for the preparatory schools of a state at cost. Much of this could be secured very cheaply by a collecting expedition to Puget Sound. The student should be given the problem of furnishing the rest of the class with a report dealing with a special form of animal life somewhat closely related to a type studied. This working out of a "lecture?" by the student is the best of training for him.

W. J. BAUMGARTNER

SPECIAL ARTICLES

AN EXPRESSION FOR THE BENDING MOMENT AT ANY SUPPORT OF A CONTINUOUS GIRDER FOR ANY NUMBER OF EQUAL SPANS

TABLES giving the bending moments at the supports of a continuous uniformly loaded girder with equal spans are found in most of the books on strength of materials, but these tables usually stop at six or seven spans. The object of this paper is to give a general expression from which the bending moment at any support for any number of spans can be computed. First the expression and explanation of the method of computation are given and then follows the derivation of the formula.

Let M_1, M_2, $\cdots$ be the bending moments at the first, second . . . support, respectively. Let n be the number of spans, w the load per unit length and l the length of span. If M_r represents the bending moment at the rth support then the formula gives

$$M_r = -\frac{\Delta_{r-2}D_{n-r+1} - D_{r-2}\Delta_{n-r}}{2\Delta_{n-1}}\,wl^2.$$

The Δs and Ds are numbers to be computed from the formulas.

$$\Delta_n = 4\Delta_{n-1} - \Delta_{n-2},$$
$$D_n = \Delta_{n-1} - D_{n-1}.$$

As shown below, $\Delta_0 = 1$, $\Delta_1 = 4$ and $D_0 = 0$ and any other Δ or D may be easily computed. For example,

$$\Delta_2 = 4\Delta_1 - \Delta_0 = 15,$$
$$\Delta_3 = 4\Delta_2 - \Delta_1 = 56,$$
$$\cdots\cdots$$
$$D_1 = \Delta_0 - D_0 = 1,$$
$$D_2 = \Delta_1 - D_1 = 3.$$

Thus, if, for example, we wish the bending moment at the fourth support for seven spans, we have $r = 4$, $n = 7$ and

$$M_4 = -\frac{\Delta_2 D_4 - D_2\Delta_3}{2\Delta_6}\,wl^2.$$

From the above formulas $\Delta_2 = 15$, $D_4 = 44$, $D_2 = 3$, $\Delta_3 = 56$, $\Delta_6 = 2911$. Hence

$$[M_4]_{7\text{ spans}} = -6/71\,wl^2,$$

a result which is verified by the tables.

The derivation of the above formula is nothing but the general solution of the equations of three moments by determinants. For n spans we have, from the theorem of three moments,

$$M_1 + 4M_2 + M_3 = -wl^2/2,$$
$$M_2 + 4M_3 + M_4 = -wl^2/2,$$
$$\cdots\cdots\cdots$$
$$M_{n-1} + 4M_n + M_{n+1} = -wl^2/2.$$

Since $M_1 = M_{n+1} = 0$ we have left $n-1$ equations with $n-1$ unknowns. If we write 1 in place of $-wl^2/2$ and multiply the final result by $-wl^2/2$ the solution will be less complicated. Writing the Ms with the same subscripts under one another we have

$$\begin{aligned} 4M_2 + M_3 \qquad\qquad &= 1,\\ M_2 + 4M_3 + M_4 \qquad &= 1,\\ M_3 + 4M_4 + M_5 &= 1,\\ \cdots\cdots\cdots\cdots \end{aligned}$$

The determinant of the system of equations will be the determinant,

$$\begin{vmatrix} 4 & 1 & 0 & 0 & 0 & \cdots \\ 1 & 4 & 1 & 0 & 0 & \cdots \\ 0 & 1 & 4 & 1 & 0 & \cdots \\ 0 & 0 & 1 & 4 & 1 & \cdots \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdots \end{vmatrix}$$

of order $n-1$. We will represent it by Δ_{n-1}. The solution of the system of equations for any unknown, say M_r, will be a fraction with Δ_{n-1} for the denominator. The numerator of the fraction will be a determinant of order $n-1$ with the same elements as Δ_{n-1} except that each element in the $r-1$th column is 1. By expanding Δ_{n-1} it is easy to see that the general formula

$$\Delta_n = 4\Delta_{n-1} - \Delta_{n-2}$$

holds. Since $\Delta_1 = 4$ and Δ_0 may be defined as 1, any Δ may be computed.

For computing the determinant in the numerator we let D_n represent a determinant of the nth order which has the same elements as Δ_n except that each element of the first column is 1. Expanding D_n, it is found that

$$D_n = \Delta_{n-1} - D_{n-1}.$$

D_0 is to be defined as 0. Now expanding the numerator of the fraction representing M_r in terms of minors of the upper $r-2$ rows, we find

$$M_r = \frac{\Delta_{r-2}D_{n-r+1} - D_{r-2}\Delta_{n-r}}{\Delta_{n-1}},$$

and multiplying this result by $-wl^2/2$ we have the general expression given at the beginning of this article. In computing a table from this formula it is of course not necessary to compute all the Ms, for the bending moments at supports equidistant from the ends are equal, that is,

$$M_r = M_{n-r+2}.$$

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SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE sixtieth regular meeting of the society was held at the Ebbitt House, February 19, 1910, at eight o'clock P.M.; President Wm. A. Taylor presided. The following papers were read:

Sprout Leaves of Western Willows: C. R. BALL, U. S. Bureau of Plant Industry.

A knowledge of the range of variation in the leaves of willows is important because a large proportion of the herbarium material must be determined from foliage specimens only. This is due to the precocious flowering of many species and the quick disappearance of the staminate aments from all, thus leaving fully half the plants in this diœcious genus with only the leaves as determining features. The pistillate aments also are gone from plants of the diœcious species before most collectors reach the field. The leaves of the so-called water sprouts are interesting because of their wide departure from the normal, especially in size and to some extent in form also.

A series of collections shows that the proportion of breadth to length found in the normal leaves is maintained in sprout leaves from the same individual in several species of the sections Pentandræ, Longifoliæ and Cordatæ from the western United States. A variation of form was found in a specimen of *S. scouleriana* (section Capreæ) from Arizona, in which the normal leaves are obovate, but those of this sprout were broadly ovate. The paper was illustrated by numerous specimens.

Bull-horn Acacias in Botanical Literature, with a Description of two new Species: W. E. SAFFORD, U. S. Bureau of Plant Industry.

There has been much confusion as to the identity of certain acacias of Mexico and Central America having large inflated horn-like stipular thorns, which are usually inhabited by ants. Linnæus placed all which had been described previously to the publication of his "Species Plantarum," under a single species *Mimosa cornigera*. Schlechtendal and Chamisso recognized the fact that the supposed synonyms cited by Linnæus included more than one species. These authors described two species found in the collections of Schiede from the state of Vera Cruz, Mexico, which they named *A. spadicigera* and *A. sphærocephala*. They leave it in doubt whether either of these species is the *Arbor cornigera*, figured and described by Hernandez (ed. Rom., p. 86, 1656), which in all probability is identical with the first plant cited by Linnæus, under his description of *Mimosa cornigera*.

In the National Herbarium are specimens of a bull-horn acacia from the type region of Hernandez's plant, collected by Dr. Edward Palmer. There are also at least two others quite distinct from any species hitherto described, one of them from Guatemala, with the inflorescence in spherical heads and with very long slender dehiscent pods; the other from the state of Chiapas, southern Mexico, with spadix-like inflorescence and

stout dehiscent pods. *Acacia cornigera* L. differs from both of these in having inflated indehiscent pods terminating in a spine-like beak, as well as in the character of its inflorescence and of the extrafloral nectaries on its leaves.

Acacia cookii sp. nov. Flowers in spherical heads on long stout peduncles clustered in the axils of large slender thorns resembling the prongs of a fork which usually straddle the stem; leaves large, with many pairs of pinnæ and many elongated nectar glands borne on the upper side of the grooved rachis; pods linear, 30 cm. or more in length, slightly curved, dehiscent. Based on specimens collected by Mr. O. F. Cook at Secanquim, Alta Verapaz, Guatemala (in alcohol), and by Mr. G. P. Goll, at the Finca Trece Aguas, in the same region, March 8, 1907 (No. 102).

Acacia collinsii sp. nov. Flowers in spadix-like spikes, usually in clusters of four or five, the oldest spike usually sessile or nearly so, the rest on long stout peduncles; bractlets of the inflorescence peltate circular, covering the unopened flowers, but concealed after anthesis; leaves with several round bead-like nectar-glands at the base of the petiole and a single gland on the rachis at the base of each pair of pinnæ; thorns stout, U-shaped; one of the arms usually perforated by ants, as in the case of other "bull-horn" acacias; pods stout, thick, short, straight or slightly curved, dehiscent, filled with yellow sweetish aril in which the seeds are imbedded. This species is based on specimens collected by Mr. Guy N. Collins between Chicoasen and San Fernandino, in the state of Chiapas, southern Mexico, January 14, 1907 (No. 180). A species resembling *Acacia hindsii*, but differing from that species in the form of its thorns, the thickness of its peduncles, and the form and stoutness of its pods.

The Categories of Variation: W. J. SPILLMAN, U. S. Bureau of Plant Industry.

Recent work indicates that the variations with which Darwin dealt may be separated into several categories which have different relations to evolutionary change. The work of Nilsson, Johannsen and Jennings seems to have demonstrated that there is a class of variations, due wholly to environment, that are not hereditary and on which selection is without effect. These variations are coming more and more to be called "fluctuations."

It is also pretty well established that when an organism is removed from its old environment to an entirely new one it may undergo rather marked changes, apparently as the result of changed environment. The meager information at hand indicates that several individuals having exactly the same inheritance undergo the same change when transplanted to a new environment and that the change is permanent under the new environment. Some recent investigations indicate that in cases of this kind, when the organism is transferred back to its old environment, it changes back to its old form. Much more investigation is needed before this type of variation, which is sometimes called "new-place effect," can be properly catalogued.

A third type of variation is that due to recombination of Mendelian characters. These recombinations frequently result in the production of new forms which are stable and must therefore be looked upon as one means of progressive evolution.

Apparently a fourth type of variation is that discovered by de Vries in *Œnothera*. The investigations of Gates and Miss Lutz point to the assumption that the variations studied by de Vries are due to the loss, gain or exchange of chromosomes in mitosis.

There are probably many other types of variation which have not yet been recognized. On *a priori* grounds it would appear almost certain that changes in the chemical composition of the germ plasm or in the relative amounts of substances present in the germ plasm are of fundamental importance in evolution, and that in the main evolutionary progress is due to them. These changes may take place in any part of the germ cell which has a determining influence on development. It was suggested that when such a change occurs in the composition of a chromosome the new form resulting would give Mendelian phenomena when crossed with the old form, but if the change occurs in cytoplasm Mendelian phenomena would be lacking, and there is some evidence that this is the case. A case in point is that of albomarginate leaves studied by Baur. The behavior of the cross is such as to indicate that the albomarginate character is cytoplasmic, and the inheritance of this character is non-Mendelian.

W. W. STOCKBERGER,
Corresponding Secretary

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

AT the 445th regular meeting, held March 29, 1910, the first paper of the evening was on "The White-dog Feast of the Iroquois," by Mr. J. N. B. Hewitt.

The white-dog sacrifice of the Iroquois is a

congeries of independent rites, ritually interrelated at this ceremony, designed to renew through the orenda or immanent magic power of these rites the life powers of living beings, the fauna and flora of nature, which are ebbing away to their extinction by the adversative action of the powers of the winter god. The embodiment of all life is Teharonhiawagon, or the "Master of Life." One of the functions of a tutelary is to reveal in a dream what is needful for the restoration of the life force of its possessor. The tutelary of Teharonhiawagon reveals to him in a dream that a victim, primarily a human being but symbolized by a dog in modern times, with an offering of native tobacco, would restore the life forces which he embodies, and with a performance of all the sacred rites of the people at this time for the purpose of disenchanting all his aids and expressions—the bodies and beings in nature. These rites therefore seek to compel the return of the sun, the elder brother of man, to the north from his apparent departure southward. The rites performed at this new year ceremony are the rekindling of new fires on the hearths of the lodges, the disenchantment of individuals by passing through the phratrial fires lighted in honor of Teharonhiawagon in the assembly-hall, the rechanting of the challenge songs of individual tutelaries to rejuvenate them, the "divining of dreams" for the restoration of the health of individuals, and for the purpose of ascertaining the revealed tutelaries of persons and children who have no tutelaries, the sacrifice of a victim to restore the health of Teharonhiawagon, and finally the performance of the four ceremonies of the tribe, the latter consuming the better part of four days in their performance. Such is in brief the ceremony of the Iroquois Onnonhwaroia, or new-year festival.

The second paper was presented by the president of the society, Dr. J. Walter Fewkes, on "The Return of the Hopi Sky-god."

The Hopi, said the president, shared with many other tribes of North American Indians, the idea of an annual return in spring time of a sky-god to revivify the earth. This conception, which is wide-spread among the pueblos, accounts in part for the belief in a future advent of Montezuma, or a fair-god, and explains certain ceremonial representations prominent in sun worship. It is so deeply rooted in Hopi myths that we find the return of the sky-god dramatized by a personation of this being accompanied by elaborate rites. From the composite nature of the Hopi ritual, dramatizations of this advent are duplicated, varying somewhat in detail, although remaining the same in general intent.

The sky-god is regarded by these Indians as the god of life, who by magic power annually rejuvenates the earth, thus making possible the germination and growth of crops which furnish the food supply of the Hopi. Some variants of this drama are performed at Walpi in late winter; others in early spring. One of the several presentations, mentioned by Dr. Fewkes, was the personation of the sky-god which occurs about Easter in a complex drama called the Powamu. The main object of this ceremony is to discharm or disenchant the earth which throughout the winter is supposed to have been controlled by a malevolent being. In this ceremony the sky-god, under the name of the returning one, is supposed to lead his followers, the clan ancients, or Kachinas to the pueblo, fructifying the earth and thus bringing back the planting and much-desired harvest time. Clad in prescribed paraphernalia, the personator of the sky-god, wearing the mask of the sun, enters the pueblo at sunrise from the east, and proceeding to every sacred room and clan house, receives the prayers of the owners of the dwellings, for abundant crops, giving in return, as symbols of a favorable reply, sprouting corn and beans. As he does so he marks each doorway with sacred meal and bowing to the rising sun, beckons to his imaginary followers to bring blessings to the people—blessing always being abundant crops and copious rains.

Certain clans now living in a pueblo near Walpi called Sichumovi, whose ancestors claim to have originally come from Zuñi, celebrate the return of their sky-god with slight variations, but with the same intent. The symbolism which distinguished the personators of the sky-god and his followers in this pueblo was brought by clans from Zuñi several years ago. Other clans that according to legends migrated to Walpi from southern Arizona perform a characteristic dramatization of the return of their sky-god, the advent of which occurs at the time of the winter solstice. Here the personator of the sky-god represents a mythic bird, whose realistic return is dramatized in the kiva or sacred room. At sunrise on the following morning, accompanied by two corn maidens, the sky-god, no longer a bird personator, distributed seed corn to representatives of the clans of the pueblos.

The ceremonies accompanying the return of the sky-god at the winter solstice are many and com-

plicated. Some of these are designed to disenchant the earth, while others draw to the pueblo the gods of germination. The prayers are said to the plumed serpent, represented by an archaic effigy, to fertilize the earth. A personation of the sky-god carrying the effigy of the plumed serpent, emblematic of lightning, forms one act of the great theatrical ceremony in the month of March; this act is performed at night in the kivas in the presence of the whole population of Walpi and neighboring villages, and represents the return of the sky-god, and the renewal of life on the earth made dormant by the sorcery of evil-minded gods.

I. M. CASANOWICZ,
Secretary

THE BIOLOGICAL SOCIETY OF WASHINGTON

THE 468th regular meeting of the society was held March 19, 1910, in the main hall of George Washington University, with President T. S. Palmer in the chair and a good attendance of members. Sixteen new members were elected.

Under the heading brief notes and exhibition of specimens Professor W. J. Spillman exhibited specimens of hoofs and foot bones of the solid-hoofed, or mule-footed, hog, a breed now well established but by no means new, since it was known 2,000 years ago.

H. W. Clark reported that he had observed numerous birds and insects feeding on sap that had oozed from a wounded spot on a red-oak tree. Among the birds were the humming bird, woodpeckers and flycatchers.

The following communications were presented:

The Birds of Midway Island: PAUL BARTSCH.

This paper was illustrated with photographs and specimens to show the use of the McIntosh reflectoscope.

The International Fisheries Regulations: BARTON W. EVERMANN.

The paper by Dr. Bartsch was discussed by President Palmer and others; that of Dr. Evermann was also discussed by the president.

THE 469th regular meeting of the society was held April 2, 1910, in the west hall of George Washington University, with President Palmer in the chair.

Under the heading brief notes, Dr. C. Dwight Marsh reported the receipt of some interesting copepods from Dr. V. L. Shelford, of Chicago University. Among them was the species *Diatomus Righardi*, obtained from northern Lake Michigan.

President Palmer reported that Professor John B. Watson, of Johns Hopkins University, would act as warden of the Tortugas Bird Reservation during the present season, and under the auspices of the Carnegie Institution would continue his investigations of the homing instincts of the noddy and sooty terns. These birds, carefully marked, will be carried farther north on the Atlantic coast and inland than in former experiments and also to the north and west sides of the Gulf of Mexico with a view to determining the length of time in which they find their way back to the nesting grounds.

The following communication was presented:

A Hasty Visit to some Foreign Zoological Gardens (illustrated with slides): A. B. BAKER.

Mr. Baker's recent visit to Nairobi, Africa, to bring home the animals presented to the National Zoological Park by Mr. W. N. McMillan, afforded an opportunity to visit some of the foreign zoological gardens. Brief visits were made to those at Manchester, London, Antwerp, Rotterdam, Amsterdam, Berlin, Halle, Frankfort, Hamburg, Leipzig, Breslau and Vienna in Europe and to the Gizeh gardens in Egypt. A description of the grounds and buildings was given. The illustrations were mainly from ordinary picture post cards, thrown on the screen by a reflectoscope.

D. E. LANTZ,
Recording Secretary

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE

THE thirty-seventh meeting was held at the Physiological Laboratory of the New York University and Bellevue Hospital Medical College on Wednesday, February 16, 1910, at 8:15 P.M., with President Lee in the chair.

Members Present: Atkinson, Auer, Banzhaf, Cole, R. I., Flexner, Gies, Hiss, Jackson, Joseph, Lee, Levin, Lusk, Mandel, A. R., MacCallum, McClendon, Meltzer, Morgan, Morse, Opie, Park, Rous, Shaklee, Stockard, Van Slyke, Wallace, Weil.

Officers elected: President—Dr. T. H. Morgan; *Vice-president*—Dr. W. J. Gies; *Secretary*—Dr. E. L. Opie; *Treasurer*—Dr. Graham Lusk.

New members elected: Dr. J. V. Cooke, Dr. A. R. Dochez, Professor J. B. Leathes.

Scientific Program

"A New Method for Determining the Activity of Ferments and Antiferments," R. Weil and S. Feldstein.

"Resistance to the Growth of Cancer Induced in Rats by Injection of Autolyzed Rat Tissue," Isaac Levin.

"Parenteral Protein Assimilation," P. A. Levene and G. M. Meyer.

"The Inhibitory Effect of Magnesium upon Indirect and Direct Irritability of Frog Muscle and the Antagonistic Action of Sodium and Calcium upon this Effect," Don R. Joseph and S. J. Meltzer.

"On the Vaso-motor Nerves of the Stomach," R. Burton-Opitz.

"The Change in the Venous Blood-flow on Administration of Amyl Nitrate," R. Burton-Opitz and H. F. Wolf.

"The Fate of Embryo Grafted into the Mother," Peyton Rous.

"The Behavior of Implanted Mixtures of Tumor and Embryo," Peyton Rous.

"Vaughan's Split Products and Unbroken Protein," Edwin J. Banzhaf and Edna Steinhardt.

"Notes on Sensitization with Tuberculin to Tubercular Rabbit's Serum," J. P. Atkinson and C. B. Fitzpatrick.

"Remote Results of the Replantation of the Kidneys," A. Carrel.

"Temporary Diversion of the Blood from the Left Ventricle to the Descending Aorta," A. Carrel.

"Remote Result of the Replantation of the Spleen," A. Carrel.

"The Mechanism of the Depressor Action of Dog's Urine with Remarks on the Antagonistic Action of Adrenalin," R. M. Pearce and A. B. Eisenbrey.

"On the Elimination of Bacteria from the Blood through the Wall of the Intestine," Alfred F. Hess.

EUGENE L. OPIE,
Secretary

THE AMERICAN CHEMICAL SOCIETY
RHODE ISLAND SECTION

A SPECIAL public meeting of the section was held in Rhode Island Hall, Brown University, on the evening of March 4, 1910, at 8 o'clock.

Professor Charles E. Munroe, dean of the graduate department of George Washington University, Washington, D. C., and consulting expert for the United States government at the Pittsburg Testing Station, Pittsburg, Pa., gave a stereopticon lecture on the subject "The Testing of Explosives for Use in Coal Mines, with special reference to the Prevention of Mine Disasters."

The lecturer first called attention to the enormous increase in the production of coal in the United States and then, in the discussion of the casualties attending coal mining, pointed out that whether the comparison was made on the basis of output or on the basis of the number of men employed, the loss of life was greater in the United States than in European countries. In 1907, under the auspices of the United States Geological Survey, an investigation was begun at the George Washington University to determine the reason for the difference. It was found, he said, that a reason lay in either the improper use of explosives or the use of improper explosives. While the university's investigation was being carried on, a series of serious disasters occurred at the Monongah mines, West Virginia, the Darr and Naomi mines in Pennsylvania and the Yolande mine in Alabama, in which 623 men were killed. These mine horrors aroused public opinion to such an extent that a suitable appropriation was made for an experimental inquiry into the nature of the explosives offered for use. A well-equipped testing station was opened on the arsenal grounds at Pittsburg, Pa., and since that time testing of explosives has been carried on with a view to determining which is most suitable for use in coal mines. After testing these explosives to determine the power and sensitiveness of each, in comparison with a certain grade of dynamite, which is taken as a standard, charges of known weight are fired, by detonation, from a very strong gun, into a mixture of natural gas, such as occurs in coal mines, and air, or natural gas, coal dust and air, or simply a mixture of coal dust and air, which mixtures are confined in a long cylindrical gallery made of boiler plate, to ascertain whether or not the charge of explosive when fired will cause the explosion of the mixture in the gallery. The gallery represents a gallery in the mine, and the hole in the gun represents the bore-hole in the coal in the mine. A limit charge of explosive is fixed upon, and if this quantity of explosive causes an explosion in the gallery, the explosive is rejected, but if it does not cause an explosion, the explosive is styled a permissible explosive, and is recommended for use. Since the establishment of the testing station at Pittsburg, 171 different explosive substances have been tested, and of these 51 have been put upon the list of permissible explosives.

ALBERT W. CLAFLIN,
Secretary

PROVIDENCE, R. I.

SCIENCE

FRIDAY, MAY 6, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

BOTANICAL GARDENS[1]

THE ADMINISTRATION OF BOTANICAL GARDENS

THE common idea of a botanical garden appears to be that of a collection of many kinds of plants chiefly marked by their lack of beauty and unattractive arrangement. A fair average impression of most botanical gardens would perhaps be that of large collections of living plants, grouped for reasons of economy and convenience, like the bottles on the shelves of a laboratory, with little regard to their individual or collective appearance: variety and some sort of classification are fundamental elements of this mental picture. It is a question how far this idea may be modified without passing the limits of popular acceptance of any definition that may be given of a botanical garden.

Such gardens originated in the herb gardens of the middle ages, which were almost as natural an outgrowth of the use of simples as a field of wheat or yams was of the use of vegetable food—though later reached. With the teaching of medicine they became demonstration gardens closely limited to the vegetable materia medica. Travel and exploration brought to them the curiosities of the vegetable kingdom. With the development of taxonomy, they have become its exponents, varying into epitomes of local or cosmic plant communities. Morphology and physiology, as these subjects progressively claimed attention, have in turn left their imprint on the gardens. Through it all, variety and economical and

[1] A symposium given before Section G, American Association for the Advancement of Science, at the Boston meeting, Tuesday, December 28, 1909.

convenient arrangement have persisted as dominant characters, the recessives or mutants rarely proving in close enough harmony with environment to hold their own apart, unless protected.

The average botanical garden, in fact, is a museum of living plants, and as such is affected by whatever affects museums of other classes. It exists for the exemplification of coordinated facts; for the provision of material for dissociated demonstration and for study; and, in so far as it can meet the requirement, it is charged with the duty of making such study of its materials. Departure from this average tends to convert it into a show-window, a warehouse or a laboratory, according to the direction and degree of specialization.

The administration of a garden of this type rests upon fundamental principles common to the fields of business, education and research. Few visitors to a museum or a garden carry away a distinct impression of fifty objects, though they have gazed upon and perhaps observed hundreds—while they may have seen thousands. If they have derived pleasure and an impression that the collection is worth while, and have carried away an understanding of something not before so well understood, they are likely to return and to send others to see what they have seen. The second, and especially the last, of these results depends upon some salient feature of the exhibit. Beauty, taste and order may give pleasure and make a collection worth seeing for the general impression it creates; but a lesson is much more often taught than picked up. In this lies a strong reason for supplementing even the greatest collections by synopses of various kinds and for frequently changing or alternating these. This principle is a rule in retail commerce; it is understood in the best museums, and is admirably practised in the display of works of art. The out-of-door plantations of a garden are less tractable in some ways than merchandise, paintings or collections of gems, prepared animals, or such botanical material as is usually found in museums or even in plant houses; but if the arrangement of the grounds is right, these may be supplemented by a great variety of special features knit into or appended to the general plantation in such a way as not to affect its unity of design.

Enough—but not too much—of everything is an essential rule, which applies with increasing force as one passes from the general to the particular—from landscape to lesson; perhaps nowhere so forcefully as in marking an exhibit. Essential are a key-map to the whole, from which its purpose and the location of its larger units are quickly ascertained; group and synopsis markers exemplifying the happy mean between obtrusiveness and obscurity; increasing prominence to the details of supplementary collections; and everywhere and for everything labels showing at least the common and botanical names, the geographic home, and a key to the history of each individual. Too much of or on a label may be as bad as too little, and what I have indicated, if truly and legibly but unobtrusively presented for each specimen, opens the books for all that is known of it and its kind. But when it is transferred from its place among the marshaled reserves to a position in which it exemplifies some special fact it acquires a need of justifying this place which is best met by increased information on its label. A collection of plants, though accurately named, is but a living atlas, the special meaning of which calls for explanatory text; and this, if appreciated, points to strict limitation and descriptive labeling of those parts of a collection which, permanently or tran-

siently, are charged with conveying special information—success in this, as in the choice of material, lying between too little to convey the desired lesson and too much to be examined or understood.

The research use of a garden, as of a museum, introduces considerations quite different from those necessarily encountered in providing for its use as a means of giving pleasure or conveying information, not the least of these being that every dollar spent for these purposes may mean a dollar less for such research. Just as many museums are compelled to limit their activity to the educational display of their treasures, many gardens find no means for doing more than to present object lessons in the vegetable kingdom either to persons who visit them in its quest or by providing demonstration material for the class room. Adequately planned and economically administered to this end, a garden is indispensable wherever botany is taught as a biological science; and few European universities have failed to include it in the equipment of a botanical department. If the department is a live one, the same forces which impel its professors to snatch from teaching some small part of their time and strength for investigation are almost sure to convert a part of the garden into an implement of research.

It is here that one difficulty in defining a botanical garden enters. A very complete gradation might be marked between so typical and well-rounded an establishment as that at Kew and the grounds of one of our agricultural experiment stations—or, to follow another cleavage line, a park planned to convey knowledge of trees and shrubs while serving its main purpose as a breathing place and recreation spot.

Most botanists will probably agree that any adequately planned and conducted garden devoted to the educational demonstration or productive investigation of plants is a botanical garden, irrespective of breadth or specialization in performing these functions. No small part of the cost of maintaining an ordinary botanical garden is incident to the need of making and keeping it presentable and of cultivating in it plants that require much care and the provision of special conditions for their growth. Even with the best that can be done for them, such plants often appear little more happy in their cramped and artificial surroundings than the animals in a menagerie; and as a class they are perhaps even less indicative of the species they are labeled as representing. Necessary as such surrogates may be, they afford a nominal rather than a real foundation for demonstration, morphological investigation or physiological experimentation. For the latter purposes, and particularly the last-named, supplementary research gardens are necessary, where tropical, desert, alpine or marine conditions are afforded by nature. Dissociated from the centers of human activity, as many such establishments must be and as all, perhaps, might profitably be if their purpose is the solution of life problems, they need not necessarily be burdened by the prior liens on the parent garden; and if of independent origin, for specific study, they necessarily should not bear these trammels. Indeed, from such special-purpose research gardens or garden-adjuncts productive results are as confidently to be expected as from the laboratory or the study as contrasted with a table and a book-shelf somewhere in the house. Research gardens of this type, limited to and concentrated on a specific line of inquiry, are likely to appear with increasing frequency in the next few decades. The results that come from them should bear a close ratio in quantity and quality to the freedom for investigation enjoyed

by the men who are privileged to make and use them; and in economy to the absence of cost other than for meeting the needs of the work in progress at any given time. That they are more likely to be adjuncts rather than independent establishments, in the main, is quite probable, because of the impossibility of doing much thorough-going and far-reaching work apart from the university and other centers about which libraries, herbaria, varied laboratories and extensive collections of living plants have clustered, and to which frequent pilgrimages are sure to be necessary.

The arrangement of this program assigns to me only an analysis of the general meaning and administrative problems of botanical gardens, and I am fortunately able to leave to specialists in their several fields the discussion of these phases of botanical gardening that have been touched on only that I might indicate how truly any worthy research plantation is, in fact, a botanical garden.

To the world at large, nevertheless, a botanical garden is likely to continue to mean, as it now means, a place where plants are attractively and instructively displayed —a museum of living plants. Professor Britton will tell, more forcibly than I could, of its duty to the public, and of the succor to be hoped for from the public that makes it very unwise to overlook this fact, even for a moment. Rather than the garden which is an adjunct to the class room and laboratory, and the research garden pure and simple, therefore, *the* botanical garden of the future, *par excellence*—the garden that appeals to the community as being worth while and that reaches beyond the confines of the class room and the laboratory in its direct usefulness—is likely to adopt in its administration more and more the best rules of museum administration, to appeal to the esthetic sense first, that through it the mind—and perhaps ultimately and incidentally the pocket-book—may be reached. Only so can it reach its goal as a force in education, and through this come into its own as a maker as well as a giver. To do this, it must be beautiful as well as varied, specialized and didactic; and its interest and attractiveness must last through the seasons. Few educational synopses or research plantations are capable of standing this test, and a fatality seems to attend their continued maintenance. In my judgment, the botanical garden of the future that is to appeal to the public like those that (as the one at Kew) most forcefully make this appeal to-day, will be devoted primarily to the presentation of plants in great variety, careful culture and artistic arrangement, and at once exemplifying and indexed by an understood taxonomy; teaching special lessons and reaching special ends through adequate supplementation.

Guided by a botanist whose first love is a broad comparative knowledge of the vegetation of the earth, planned by an artist whose skill can convert the picture of his mind into something that the eye can see, cared for by a gardener to whom a dandelion or a dock in place is as desirable as an oak or an orchid out of place is undesirable, such a garden calls for the further constant care of the teacher to insure through unceasing watchfulness that what is intended to be educational shall be kept from becoming near-demonstration, and the alert supervision of the investigator in each field of research so that experiment may not turn into chance and supposedly adequate resources prove quite inadequate when drawn on at a critical moment. These talents are rarely if ever embodied in one person. The garden that is to profit by them is likely to cherish their possessors in the order indicated, even though, finally, in

taking rank in the achievement of its highest aim—the enlargement of knowledge—there are last which shall be first and there are first which shall be last.

William Trelease

THE BOTANIC GARDEN AS A FIELD MUSEUM OF AGRICULTURE

A fully equipped botanic garden serves more or less strongly a variety of useful purposes. To the public at large its chief function may appear to be that of a park or amusement ground where the dweller in flats may find, amid the fresh beauties of a productive soil, rest and refreshment for his soul, wearied by the daily dash over a city's well fertilized but unproductive pavement, and where the nurse-maid may sit reposefully on a shaded bench and give her charge a needed airing without fear of death by passing automobiles or beer wagons. To one interested in plants for their own sake, the botanic garden often means a place where may be found growing in conservatories or in the open rare plants of native and foreign origin—strange types that travelers tell us of in their wonder books—tree ferns, palms and exotic orchids. In European gardens American trees may be most strikingly present, while in American gardens it is the European trees that catch our eyes. The botanic garden is not, however, merely a species of plant circus that the curious may enter with the expectation of being surprised at oddities in nature and horticulture. It is primarily an attempt to represent the different types of vegetation of the world. In so doing, however, the native and agricultural flora is generally neglected on the perhaps not unnatural ground of its familiarity.

It is not in my province to discuss the various departments and aims of a modern botanic garden. I wish to speak as a teacher chiefly of the economic section already in botanic gardens, and to make some suggestions for its further development.

A systematically arranged and well-labeled botanic garden may be called a dictionary of living plants. You look up the family, the genus or the species and you find the meaning in the growing specimens or you find the known plant, and the label gives you its name and classification. Plants are not excluded from the subject-matter of the young child's continual search for the names of things. It is the fear of his frightful question, "What is it?" that has been the end of many a teacher's attempt to give simplified botany or nature study in the lower schools. To a teacher, if a botanic garden is to serve as a plant dictionary, it should be built on the type of a school or pocket dictionary. Botanic gardens are perhaps too often on the plan of those dictionaries of rarer words that have several times been published. In such a dictionary, says the author, it is needless to give common words familiar to all, as house, church and the like. Only those less familiar words, then, need be included which are at all likely to give trouble to a reading public such as pragmatism, esoteric and the like. A botanic dictionary on this plan might be expected to throw out such simple words as root, leaf and bud; but for the sake of the beginner who may stand abashed at the tangled mass of Greek and Latin roots that confront him in his pathway up the steep ascent of botanic knowledge, explicit definition might be expected of such words as "the law of priority," heterotypic division, and of the recent verbal immigrants of Greek origin not yet out of the quarantine of public opinion. Few of these dictionaries of rarer words are actually in use, for practise has shown that on the whole it is the common

words which are most often looked up in a dictionary. I do not have to remind the members of the section that at the Washington meeting in 1903, a committee was appointed to define the simple word "bud," and their difficulties apparently have been so great as to prevent them reaching a unanimous conclusion, since no report of this committee has been recorded.

In the Connecticut Agricultural College an attempt has been made to establish a garden largely on the plan of the pocket dictionary and a concrete description of what has been accomplished and what has been planned for this garden, may perhaps be the best method of bringing before the section what I have to say on the subject assigned me.

The public for which this garden has been planned is composed, first of regular students in the agricultural college, secondly of students in the summer school who are for the most part teachers throughout the state, and thirdly of visitors who are more or less interested in agriculture.

One section is devoted to school gardens, which are planted and kept in condition by school children of the neighborhood, and which serve as examples to the members of the summer school class in school gardening.

The largest division is the systematic section. In it are grown, arranged according to their family relationships, in full plots 9 × 5 feet in size or in half plots, all the chief species of agricultural importance in the state. So far as conditions will allow, the different plants are grown in the same way in which they are cultivated as farm or garden crops, and this section might well, therefore, be called a "crop garden." The familiar weeds, however, and some of the commoner wild plants are included in their proper order along with the economic forms. The Solanaceæ may serve as an example of the arrangement of one of the families. A plot of cherry tomato heads the row and with its small berry of two carpels shows the primitive condition of fruit. This is followed by varieties to show the modifications in the fruit brought about through cultivation in size, shape, color, texture of coat and number of carpels. In the row are also represented varieties of egg plant, peppers, potato, black nightshade and its more cultivated, though morganatic sisters—the garden huckleberry and wonderberry, as well as bitter sweet; petunias—single and the derived double-flowered form; tobacco; jimson weed, and matrimony vine. In a similar fashion the Leguminosæ, Gramineæ, the Cruciferæ and the more important genera are represented by native and cultivated forms.

The question which decides the admission of a native form is not, "Is it rare?" but "Is it common?" Perhaps the rarest flowers in the garden are those that are seen on such common biennials as cabbage, beets and parsnips which are planted the second year and allowed to show their systematic position by their flowers and fruit. The commoner ornamental plants are not neglected. Among the Compositæ, for example, dahlias, sunflowers and golden glow will be found alongside of lettuce and chicory, and among the Liliaceæ day lilies are found as well as leeks and onions. It is a continual source of wonder to the visiting agriculturalist to see in a botanic garden the dandelion lying down by the side of the lamb's quarters, and both led to live within bounds a life of unobnoxious cultivation. These weeds, as also the pig-weed and "pusley" scorned by the farmer, are known to every boy with the hoe, yet experience shows that their names are often confused. The very commonness of the dandelion makes it all the better as a type to head the row of the composite family.

Edible fruits are left to ripen on the

plants, and seem to have an educational value in that they attract students to the garden, where they may unconsciously have botanical knowledge thrust upon them. Certain it is that the freshmen who made voluntary investigation of the Cucurbitaceæ this last fall have come to appreciate the distinguishing characters of some members of the order—if one can judge by the number of citrons that were found opened by mistake for watermelons.

Where possible the primitive wild form is grown to show the improvement which has been brought about under cultivation. Thus, seed has been obtained of the wild tobacco (*Nicotiana rustica*) of *Triticum dicoccoides*, recently discovered in Palestine, and considered the source of emmer wheat; vines of native grapes and of *Vitis vinifera* show the sources from which our cultivated varieties have been compounded.

A third division is devoted to pathology. A few of the great groups of parasitic fungi may be represented, such as corn smut, wheat rust, with its alternate form on barberry, black knot of cherry, etc. A variety of bean susceptible to anthracnose will be grown in a plot adjacent to an immune variety, and a striking demonstration of the value of immune races may be expected. Plots can be sown with a mixture of grain and weed seeds and the effect of spraying with iron salts upon the competing plants be shown. The "calico" or mosaic disease of tobacco is a convenient type to illustrate a disease which is transmitted by inoculation, but which is apparently not caused by any living organism. Every other plant touched in a row with an infected leaf will contract the disease, and will form a sharp contrast to the uninoculated individuals left as controls. Non-infectious chlorosis of leaves and chlorosis through grafting may be better illustrated in shrubby forms.

A fourth section of the garden contains specimens to illustrate the laws of variation and heredity. Variations are the building stones out of which the plant-breeder forms his new "creations," and as such should be well classified. Variation in vigor of growth or in qualities of fruit may be due to inherent characters in the germ, which are more or less hereditary and therefore capable of transmission, or on the other hand they may be the response of the plants to recognizable differences in their environment. In the latter group would come the increased growth due to an increase of available food supply. For an illustration there may be grown plots of tobacco in poorly and richly manured soil to show the effect of abundance and lack of food in the substratum. The contrast between the growth of corn sown separately in hills, and the same plant sown thickly in drills, will show the effect of lack of food brought about by competition. In practise tobacco seed is blown, the light which produce small plants being rejected and the heavier reserved for sowing. Plots of tobacco from heavy and light seed, respectively, may be used to show the variation in adult plants due to the differing amount of storage food in the seed.

Fluctuating variations about a mean may be shown by sowing seeds from a single parent and comparing the offspring in respect to a single character. Plants can be grown to show in how far a selection of these fluctuations may be able to change the characters of a given plant. Indian corn furnishes a good example, since in addition to changes in the percentage content of protein, fat and starch in the grain, other clearly defined characters, such as the number, size and position of the ears on the plant, and the number of grains to the ear, have been shown to be markedly influenced by such selection.

Ever-sporting varieties may be illustrated by such races as the five-leaved clover of de Vries and his fasciated teasel. The theory of mutation can not be better illustrated than by the classical example of Lamarck's evening primrose with some of its most striking mutants.

Hybridization, as one of the most important means of effecting changes in combination of plant characters, demands a prominent consideration in the section of the garden under discussion. Mendel's law can perhaps best be shown by hybrids between white- and scarlet-flowered races of a free-blooming species like the scarlet runner bean in which the color characters are evident in vegetative as well as in floral parts, and the assumption of color factors is not necessary to explain the color relations of the offspring. If suitable examples can be obtained, blend and mosaic hybrids might also be illustrated.

Due to hybridization and other causes, the sexually formed seed can not be depended upon to reproduce the characters of the parents without change. Vegetative means of reproduction such as cuttings, since they merely increase the individual plant, do, however, reproduce individual characters. Sowings from seeds and roots respectively, from a single plant of some modern type of dahlia would show the truth of the saying, that cuttings come true, but seedlings do not.

It has been the writer's practise to have each student choose some single plant for personal investigation to find out from the plant itself as much as possible without unfavorable prejudice from literature. The amount of work has been largely voluntary and a reasonable proportion of the students have responded to the suggestions offered them for this elementary research work. A portion of the garden is reserved for carrying out cultures and experiments, which the students themselves may suggest, in connection with their plants under investigation.

The special type of botanic garden which has thus been outlined by specific examples is the outgrowth of the needs of a teaching botanist in an agricultural institution. It has furnished material for demonstration purposes, for laboratory exercises and for field observations. Its systematic section being built on the plan of the pocket dictionary with the most used forms represented has been considered as forming a not unnatural basis of a student's list of recognizable plants, and accordingly ability to identify the species grown in the garden has been expected of students taking botany.

Though the chief function of the agricultural botanic garden may be considered as being instructional for special courses, it should prove of interest to students outside their classes and to a visiting public. It may, therefore, be not inappropriately termed a field museum of agriculture.

A. F. Blakeslee

THE PSYCHOLOGY OF SOCIAL CONSCIOUSNESS IMPLIED IN INSTRUCTION[1]

I have been asked to present the social situation in the school as the subject of a possible scientific study and control.

The same situation among primitive people is scientifically studied by the sociologist (folk-psychologist). He notes two methods in the process of primitive education. The first is generally described as that of play and imitation. The impulses of the children find their expression in play, and play describes the attitude of the child's consciousness. Imitation defines the form of unconscious social control

[1] Read before Section L—Education. American Association for the Advancement of Science, Boston, December, 1909.

exercised by the community over the expression of childish impulse.

In the long ceremonies of initiation education assumed a more conscious and almost deliberate form. The boy was induced into the clan mysteries, into the mythology and social procedure of the community, under an emotional tension which was skilfully aroused and maintained. He was subjected to tests of endurance which were calculated not only to fulfil this purpose, but also to identify the ends and interests of the individual with those of the social group. These more general purposes of the initiatory ceremonies were also at times cunningly adapted to enhance the authority of the medicine man or the control over food and women by the older men in the community.

Whatever opinion one may hold of the interpretation which folk-psychology and anthropology have given of this early phase of education, no one would deny, I imagine, the possibility of studying the education of the savage child scientifically, nor that this would be a psychological study. Imitation, play, emotional tensions favoring the acquirement of clan myths and cults, and the formation of clan judgments of evaluation, these must be all interpreted and formulated by some form of psychology. The particular form which has dealt with these phenomena and processes is social psychology. The important features of the situation would be found not in the structure of the idea to be assimilated considered as material of instruction for any child, nor in the lines of association which would guarantee their abiding in consciousness. They would be found in the impulse of the children expressed in play, in the tendency of the children to put themselves in the place of the men and women of the group, *i. e.*, to imitate them in the emotions which consciousness of themselves in their relationship to others evoke, and in the import for the boy which the ideas and cults would have when surcharged with such emotions.

If we turn to our system of education we find that the materials of the curriculum have been presented as percepts capable of being assimilated by the nature of their content to other contents in consciousness, and the manner has been indicated in which this material can be most favorably prepared for such assimilation. This type of psychological treatment of material and the lesson is recognized at once as Herbartian. It is an associational type of psychology. Its critics add that it is intellectualistic. In any case it is not a social psychology, for the child is not primarily considered as a self among other selves, but as an *apperceptionsmasse*. The child's relations to the other members of the group, to which he belongs, have no immediate bearing on the material nor on the learning of it. The banishment from the traditional school work of play and of any adult activities in which the child could have a part as a child, *i. e.*, the banishment of processes in which the child can be conscious of himself in relation to others, means that the process of learning has as little social content as possible.

An explanation of the different attitudes in the training of the child in the primitive and in the modern civilized communities is found, in part, in the division of labor between the school on the one side, and the home and the shop or the farm on the other. The business of storing the mind with ideas, both materials and methods, has been assigned to the school. The task of organizing and socializing the self to which these materials and methods belong is left to the home and the industry or profession, to the playground, the

street and society in general. A great deal of modern educational literature turns upon the fallacy of this division of labor. The earlier vogue of manual training and the domestic arts before the frank recognition of their relation to industrial training took place, was due in no small part to the attempt to introduce those interests of the child's into the field of his instruction which gathers about a socially constituted self, to admit the child's personality as a whole into the school.

I think we should be prepared to admit the implication of this educational movement—that however abstract the material is which is presented and however abstracted its ultimate use is from the immediate activities of the child, the situation implied in instruction and in the psychology of that instruction is a social situation; that it is impossible to fully interpret or control the process of instruction without recognizing the child as a self and viewing his conscious processes from the point of view of their relation in his consciousness to his self, among other selves.

In the first place, back of all instruction lies the relation of the child to the teacher and about it lie the relations of the child to the other children in the school-room and on the play-ground. It is, however, of interest to note that so far as the material of instruction is concerned an ideal situation has been conceived to be one in which the personality of the teacher disappears as completely as possible behind the process of learning. In the actual process of instruction the emphasis upon the relation of pupil and teacher in the consciousness of the child has been felt to be unfortunate. In like manner the instinctive social relations between the children in school hours is repressed. In the process of memorizing and reciting a lesson, or working out a problem in arithmetic a vivid consciousness of the personality of the teacher in his relationship to that of the child would imply either that the teacher was obliged to exercise discipline to carry on the process of instruction, and this must in the nature of the case constitute friction and division of attention, or else that the child's interest is distracted from the subject matter of the lesson, to something in which the personality of the teacher and pupil might find some other content; for even a teacher's approval and a child's delight therein has no essential relation to the mere subject matter of arithmetic or English. It certainly has no such relationship as that implied in apprenticeship, in the boy's helping on the farm or the girl's helping in the housekeeping, has no such relationship as that of members of an athletic team to each other. In these latter instances the vivid consciousness of the self of the child and of his master, of the parents whom he helps and of the associates with whom he plays is part of the child's consciousness of what he is doing, and his consciousness of these personal relationships involves no division of attention. Now it had been a part of the fallacy of an intellectualistic pedagogy that a divided attention was necessary to insure application of attention—that the rewards, and especially the punishments, of the school hung before the child's mind to catch the attention that was wandering from the task, and through their associations with the schoolwork to bring it back to the task. This involves a continual vibration of attention on the part of the average child between the task and the sanctions of school discipline. It is only the psychology of school discipline that is social. The pains and penalties, the pleasures of success in competition, of favorable

mention of all sorts implies vivid self-consciousness. It is evident that advantage would follow from making the consciousness of self or selves which is the life of the child's play—on its competition or co-operation—have as essential a place in instruction. To use Professor Dewey's phrase, instruction should be an interchange of experience in which the child brings his experience to be interpreted by the experience of the parent or teacher. This recognizes that education is interchange of ideas, is conversation—belongs to a universe of discourse. If the lesson is simply set for the child—is not his own problem—the recognition of himself as facing a task and a task-master is no part of the solution of the problem. But a difficulty which the child feels and brings to his parent or teacher for solution is helped on toward interpretation by the consciousness of the child's relation to his pastors and masters. Just in so far as the subject matter of instruction can be brought into the form of problems arising in the experience of the child—just so far will the relation of the child to the instructor become a part of the natural solution of the problem—actual success of a teacher depends in large measure upon this capacity to state the subject matter of instruction in terms of the experience of the children. The recognition of the value of industrial and vocational training comes back at once to this, that what the child has to learn is what he wants to acquire, to become the man. Under these conditions instruction takes on frankly the form of conversation, as much sought by the pupil as the instructor.

I take it therefore to be a scientific task to which education should set itself that of making the subject matter of its instruction the material of personal intercourse between pupils and instructors, and between the children themselves. The substitution of the converse of concrete individuals for the pale abstractions of thought.

To a large extent our school organization reserves the use of the personal relation between teacher and taught for the negative side, for the prohibitions. The lack of interest in the personal content of the lesson is in fact startling when one considers that it is the personal form in which the instruction should be given. The best illustration of this lack of interest we find in the problems which disgrace our arithmetics. They are supposed matters of converse, but their content is so bare, their abstractions so raggedly covered with the form of questions about such marketing and shopping and building as never were on sea or land, that one sees that the social form of instruction is a form only for the writer of the arithmetic. When further we consider how utterly inadequate the teaching force of our public schools is to transform this matter into concrete experience of the children or even into their own experience, the hopelessness of the situation is overwhelming. Ostwald has written a text-book of chemistry for the secondary school which has done what every text-book should do. It is not only that the material shows real respect for the intelligence of the student, but it is so organized that the development of the subject matter is in reality the action and reaction of one mind upon another mind. The dictum of the Platonic Socrates, that one must follow the argument where it leads in the dialogue, should be the motto of the writer of text-books.

It has been indicated already that language being essentially social in its nature thinking with the child is rendered concrete by taking on the form of conversation. It has been also indicated that this can take place only when the thought has reference to a real problem in the experi-

ence of the child. The further demand for control over attention carries us back to the conditions of attention. Here again we find that traditional school practise depends upon social consciousness for bringing the wandering attention back to the task, when it finds that the subjective conditions of attention to the material of instruction are lacking, and even attempts to carry over a formal self-consciousness into attention, when through the sense of duty the pupil is called upon to identify the solution of the problem with himself. On the other hand, we have in vocational instruction the situation in which the student has identified his impulses with the subject matter of the task. In the former case, as in the case of instruction, our traditional practise makes use of the self-consciousness of the child in its least effective form. The material of the lesson is not identified with the impulses of the child. The attention is not due to the organization of impulses to outgoing activity. The organization of typical school attention is that of a school self, expressing subordination to school authority and identity of conduct with that of all the other children in the room. It is largely inhibitive—a consciousness of what one must not do, but the inhibitions do not arise out of the consciousness of what one is doing. It is the nature of school attention to abstract from the content of any specific task. The child must give attention *first* and *then* undertake any task which is assigned him, while normal attention is essentially selective and depends for its inhibitions upon the specific act.

Now consciousness of self should follow upon that of attention, and consists in a reference of the act, which attention has mediated, to the social self. It brings about a conscious organization of this particular act with the individual as a whole—makes it his act, and can only be effectively accomplished when the attention is an actual organization of impulses seeking expression. The separation between the self, implied in typical school attention, and the content of the school tasks, makes such an organization difficult if not impossible.

In a word attention is a process of organization of consciousness. It results in the reenforcement and inhibitions of perceptions and ideas. It is always a part of an act and involves the relation of that act to the whole field of consciousness. This relation to the whole field of consciousness finds its expression in consciousness of self. But the consciousness of self depends primarily upon social relations. The self arises in consciousness *pari passu* with the recognition and definition of other selves. It is therefore unfruitful if not impossible to attempt to scientifically control the attention of children in their formal education, unless they are regarded as social beings in dealing with the very material of instruction. It is this essentially social character of attention which gives its peculiar grip to vocational training. From the psychological point of view, not only the method and material but also the means of holding the pupils' attention must be socialized.

Finally a word may be added with reference to the evaluations—the emotional reactions—which our education should call forth. There is no phase of our public school training that is so defective as this. The school undertakes to acquaint the child with the ideas and methods which he is to use as a man. Shut up in the history, the geography, the language and the number of our curricula should be the values that the country, and its human institutions, have; that beauty has in nature and

art; and the values involved in the control over nature and social conditions.

The child in entering into his heritage of ideas and methods should have the emotional response which the boy has in a primitive community when he has been initiated into the mysteries and the social code of the group of which he has become a citizen. We have a few remainders of this emotional response, in the confirmation or conversion and entrance into the church, in the initiation into the fraternity, and in the passage from apprenticeship into the union. But the complexities of our social life, and the abstract intellectual character of the ideas which society uses have made it increasingly difficult to identify the attainment of the equipment of a man with the meaning of manhood and citizenship.

Conventional ceremonies at the end of the period of education will never accomplish this. And we have to further recognize that our education extends for many far beyond the adolescent period to which this emotional response naturally belongs. What our schools can give must be given through the social consciousness of the child as that consciousness develops. It is only as the child recognizes a social import in what he is learning and doing that moral education can be given.

I have sought to indicate that the process of schooling in its barest form can not be successfully studied by a scientific psychology unless that psychology is social, *i. e.*, unless it recognizes that the processes of acquiring knowledge, of giving attention, of evaluating in emotional terms must be studied in their relation to selves in a social consciousness. So far as education is concerned, the child does not become social by learning. He must be social in order to learn.

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STATISTICS OF FOREIGN UNIVERSITIES

The accompanying table shows the enrollment during the winter semester (1909–10) at the universities of the German Empire, at all of the Swiss universities except Neuchâtel, and at several of the Austrian and Hungarian universities, the figures having been furnished in each instance by an officer of the institution concerned. The division into the four traditional faculties of theology, law, medicine and philosophy has been adhered to, no attempt being made to subdivide the last mentioned faculty into the two groups —(*a*) philosophy, philology and history, (*b*) mathematics and the natural sciences —represented at most of the institutions in the list. Nor has any attempt been made to provide special categories for dentistry, pharmacy, forestry, agriculture, etc., the custom being to include dentistry under medicine (or philosophy) and the other subjects under philosophy.

It will be seen from the table that 58,342 students were in attendance at the German universities, 93.5 per cent. of these being men and 6.5 per cent. women. The matriculated students constituted 90.8 per cent. of the grand total and the auditors 9.2 per cent. Of the matriculated students 96.5 per cent. were men and only 3.5 per cent. women, there being practically no women enrolled in theology and only a few in law, the great majority being found in philosophy. Of the auditors, on the other hand, no less than 36.3 per cent. were women—Göttingen, Greifswald, Königsberg, Marburg, Rostock, Strassburg and Würzburg all having more female than male auditors. Almost one half (49.4 per cent.) of the matriculated students are enrolled in the faculty of philosophy, law coming next with 21.9 per cent., then medicine with 21.1 per cent., and finally theology with 7.6 per cent.

Institutions [Winter Semester, 1909–10]	Matriculated Students: Theology, Men	Theology, Women	Law, Men	Law, Women	Medicine, Men	Medicine, Women	Philosophy, Men	Philosophy, Women	All Faculties, Men	All Faculties, Women	All Faculties, Total	Auditors, Men	Auditors, Women	Auditors, Total	Grand Total, Men	Grand Total, Women	Grand Total, Total
A—German																	
Berlin	364	3	2506	6	1499	147	4241	476	8610	632	9242	724	353	1077	9334	985	10319
Bonn	403		806	1	354	16	1901	117	3464	134	3598	171	111	282	3635	245	3880
Breslau	349		560		396	18	970	66	2275	84	2359	205	195	400	2480	279	2759
Erlangen	139		247		282	12	436	7	1104	19	1123	42	22	64	1146	41	1187
Freiburg	218		409	6	681	37	773	43	2081	86	2167	91	47	138	2172	133	2305
Giessen	70		165	3	310	21	679	13	1224	37	1261	93	59	152	1317	96	1413
Göttingen	117		431	1	252	10	1270	149	2070	160	2230	55	57	112	2125	217	2342
Greifswald	118		205		209	2	385	38	917	40	957	50	51	101	967	91	1058
Halle	306	1	453		324	8	1283	18	2366	27	2393	179	88	267	2545	115	2660
Heidelberg	62		399	6	463	50	868	86	1792	142	1934	103	52	155	1895	194	2089
Jena	43		282	1	303	10	868	13	1496	24	1520	67	52	119	1563	76	1639
Kiel	48		442		498	9	640	9	1631	18	1649	61	49	110	1692	67	1759
Königsberg	80		308	1	332	15	602	30	1322	46	1368	98	110	208	1420	156	1576
Leipzig	$\underbrace{\quad}_{347}$		$\underbrace{\quad}_{899}$		$\underbrace{\quad}_{746}$		$\underbrace{\quad}_{2769}$		4702	59	4761	755	114	869	5457	173	5630
Marburg	118	1	434		335	8	953	29	1840	38	1878	14	31	45	1854	69	1923
München	177		1423	8	2075	73	2884	102	6559	183	6742	375	204	579	6934	387	7321
Münster	313		443		215	3	881	46	1852	49	1901	121	45	166	1973	94	2067
Rostock	49		62		171	1	422	2	704	3	707	27	36	63	731	39	770
Strassburg	209		409	2	364	13	985	13	1967	28	1995	66	122	188	2033	150	2183
Tübingen	427		367		298	10	645	13	1737	23	1760	75	68	143	1812	91	1903
Würzburg	86		297		609	8	422	2	1414	10	1424	48	87	135	1462	97	1559
Total	*4048*		*11585*		*11187*		*26149*		*51127*	*1842*	*52969*	*3420*	*1953*	*5373*	*54547*	*3795*	*58342*
B—Austrian (incl. Hungarian)																	
Budapest	86		3619		1814	63	967	134	6486	197	6683	731	65	796	7217	262	7479
Czernowitz	131		573		—		152	9	856	9	865	122	67	189	978	76	1054
Innsbruck	337		266		213		186		1002		1002	174	51	225	1176	51	1227
Klausenburg			$\underbrace{\quad}_{1497}$		$\underbrace{\quad}_{321}$		$\underbrace{\quad}_{298}$				2116			191			2307
Krakau	86		1307		446	48	701	182	2540	230	2770	232	209	441	2772	439	3211
Wien	219		3418		1791	77	1880	194	7308	271	7579	1579	422	2001	8887	693	9580
C—Swiss																	
Basel	54		59		188	7	347	14	648	21	669	52	61	113	700	82	782
Bern	48		403	3	548	224	627	118	1626	345	1971	358	178	536	1984	523	2507
Freiburg	235		124		—		237	8	596	8	604	39	81	120	635	89	724
Genève	23		253	19	252	372	298	235	826	626	1452	136	327	463	962	953	1915
Lausanne	14		147	12	164	159	365	103	690	274	964	117	152	269	807	426	1233
Zürich	29		276	13	355	191	496	114	1156	318	1474	208	193	401	1364	511	1875

In point of total attendance (matriculated students and auditors) the German institutions rank as follows: (1) Berlin, (2) München, (3) Leipzig, (4) Bonn, (5) Breslau, (6) Halle, (7) Göttingen, (8) Freiburg, (9) Strassburg, (10) Heidelberg, (11) Münster, (12) Marburg, (13) Tübingen, (14) Kiel, (15) Jena, (16) Königsberg, (17) Würzburg, (18) Giessen, (19) Erlangen, (20) Greifswald and (21) Rostock. It should be remembered that the summer semester (1909) is not included in the figures, and also that several institutions, notably those located in the pleasantly situated smaller towns, have a larger attendance in the summer than in the winter. If the matriculated students only are considered, Halle would change places with Breslau, and Würzburg with Königsberg. The University of Tübingen leads in

the number of theological students, with Bonn, Berlin, Breslau and Leipzig following in the order named. In law the order is Berlin, München, Leipzig, Bonn and Breslau; in medicine München, Berlin, Leipzig, Freiburg and Würzburg, and in philosophy, Berlin, München, Leipzig, Bonn and Göttingen. Berlin attracts the most matriculated women, followed by München, Göttingen, Heidelberg and Bonn, whereas in the total number of female students, including auditors, Berlin is followed by München, Breslau, Bonn and Göttingen. The largest numbers of auditors are found at Berlin, Leipzig, München, Breslau and Bonn, in the order named.

Vienna is by far the largest of the Austrian universities, being surpassed in point of attendance only by Berlin among the German institutions, while the largest Swiss institution is the University of Bern, this being followed by Genève, Zürich, Lausanne, Basel, Freiburg and Neuchâtel. The Universities of Czernowitz and Freiburg (Switzerland) have no medical faculties. The percentage of matriculated women students at the Swiss universities (22.3 per cent.) is much higher than that (3.5 per cent.) at the German institutions, while with the exception of Bern and Zürich the Swiss universities all attract more female than male auditors.

If we compare the attendance at the German universities during the winter semester of 1909–10 with that of 1893–94,[1] we shall find that the number of matriculated students has more than doubled during this period, the gain being one of 113 per cent., *i. e.*, from 27,424 to 58,342. There were almost as many students enrolled in the faculty of philosophy alone this year as there were in all four faculties sixteen years ago, and almost as many students of medicine in 1893–94 as there were of philosophy in that year. The number of law students was exceeded by that of medical students sixteen years ago, whereas to-day the condition is reversed. The number of students of theology has shrunk from 4,587 to 4,048 during the period under consideration, or from 16.7 per cent. to 7.6 per cent. of the total number of matriculated students enrolled. The number of law students has increased from 7,024 to 11,585, but the percentage has dropped from 25.6 per cent. to 21.9 per cent., while in the case of the students of medicine there has been an actual increase from 7,856 to 11,187 accompanied by a decrease in percentage from 28.7 per cent. to 21.1 per cent. The number of students under the faculty of philosophy has more than tripled during the sixteen-year period under review, the percentage increase being one from 29 per cent. to 49.4 per cent. There may be some discrepancies in the classification of students of veterinary medicine, pharmacy, dentistry and the like, as between 1893–94 and 1909–10, but they are not likely to be of sufficient moment to affect the general situation.

There has also been a marked change in the relative position of the various German universities since 1893–94. Leaving auditors out of consideration, the institutions in the year mentioned ranked as follows from the standpoint of attendance: (1) Berlin, (2) München, (3) Leipzig, (4) Halle, (5) Würzburg, (6) Bonn, (7) Breslau, (8) Tübingen, (9) Erlangen, (10) Freiburg, (11) Heidelberg, (12) Strassburg, (13) Marburg, (14) Göttingen, (15) Greifswald, (16) Königsberg, (17) Jena, (18) Giessen, (19) Kiel, (20) Rostock and (21) Münster, the last mentioned institution possessing no law and medical schools

[1] The 1893–94 figures are based on the reports of the various institutions in volume 4 (1894–95) of *Minerva*.

in 1894. The only university that shows a decrease in the attendance of matriculated students this year as against 1894 is Würzburg, and there the loss is very slight, from 1,442 to 1,424. The largest gains in actual number of students have been made by Berlin, München, Bonn, Leipzig, Münster and Göttingen, in the order named, while the largest relative (percentage) increases have been registered by Münster, Kiel, Göttingen, Bonn, Giessen, Jena and Marburg. It is interesting to note that there are three large cities in the first group, and not one in the second, so that we may say, speaking broadly, that the institutions located in the smaller cities have experienced a greater *relative* gain than those in the large cities, while, on the other hand, the universities of Berlin, München and Leipzig alone have to their credit 37 per cent. of the gain in actual number of matriculated students made at all of the institutions together since 1894.

The following figures taken from the second volume of the report of the commissioner of education for the year ended June 30, 1909, may be of interest. They illustrate the growth of the professional schools of theology, law and medicine in our own country, and it will be seen that, contrary to the conditions in Germany, theology does not show a loss, whereas medicine, on the other hand, exhibits an increase when compared with 1890, but a decrease since 1900; law has made constant and rapid progress. Unfortunately no figures for the school of philosophy are available for the United States. In comparing the American with the German figures, it should also be borne in mind that the general standards for admission to professional courses of study in Germany are much higher than they are in our own country.

NUMBER OF STUDENTS IN ATTENDANCE AT THE PROFESSIONAL SCHOOLS OF THEOLOGY, LAW AND MEDICINE IN THE UNITED STATES

	1908–1909	1907–1908	1899–1900	1889–1890	1879–1880	1869–1870
Theology	10,218	9,583	8,009	7,018	5,242	3,254
Law	18,553	18,069	12,516	4,518	3,134	1,653
Medicine (incl. homeopathic)	22,153	22,787	25,218	15,484	11,929	6,194

RUDOLF TOMBO, JR.
COLUMBIA UNIVERSITY

SCIENTIFIC NOTES AND NEWS

DR. H. T. RICKETTS, of the University of Chicago, who has been in Mexico conducting research into the etiology of typhus fever, has died from that disease.

DR. JOHN TROWBRIDGE, who retires this year from the active duties of his chair at Harvard University, has been appointed honorary director of the Jefferson Physical Laboratory.

DR. ABRAHAM JACOBI, emeritus professor of the diseases of children in the College of Physicians and Surgeons of Columbia University, celebrates his eightieth birthday on May 6. On April 23, exercises were held at the Mount Sinai Hospital in his honor. A bronze bust was presented to the hospital by the medical and surgical staff, and a new library named in his honor was given by the board of directors. At a dinner given the same evening by the trustees of the German Hospital announcement was made that the new children's ward which Mrs. Anna Woerishoffer has given to the hospital will be known as "The Dr. Abraham Jacobi Division for Children."

SIR ARCHIBALD GEIKIE has been elected a foreign member of the Royal Danish Society of Sciences, Copenhagen.

SIR THOMAS BARLOW has been elected president of the Royal College of Physicians, London, in succession to Sir Douglas Powell.

PROFESSOR R. B. OWENS, recently professor of electrical engineering in McGill University, has been appointed secretary of the Franklin Institute, Philadelphia.

Mr. H. C. Graham, B.A., Toronto, '08, and fellow in chemistry, has been appointed chemist assistant in the Provincial Laboratory at Edmonton, Alberta.

Mr. J. E. Sears has been appointed to take charge of the work of the metrology division of the British National Physical Laboratory in the place of Mr. H. Homan Jeffcott, who has been nominated recently to the professorship of engineering in the Royal College of Science, Dublin.

Mrs. Zelia Nuttall has handed in her resignation as member of the Organizing Committee of the Seventeenth International Congress of Americanists, to be held in Mexico City next September, and has also renounced the title of honorary professor of Mexican Archeology at the National Museum, as a protest against the treatment she received from the ministry of public instruction and the inspector of monuments in connection with her recent discovery and proposed exploration of the ruin of an ancient temple on the island of Sacrificios, off Vera Cruz.

The American Philosophical Society in response to invitations received has appointed the following delegates to represent it at the International Congresses to be held during the current year. At the International Botanical Congress to be held at Brussels, May 14–21, 1910, Professor George Lincoln Goodale, of Harvard University. At the International Scientific Congress to be held at Buenos Aires, July 10–25, 1910, Dr. Louis A. Bauer, director of the department of Terrestrial Magnetism, Carnegie Institution, Washington. At the International Geological Congress to be held in Stockholm, August 18–25, 1910, Professor Harry C. Jones, of Johns Hopkins University. At the Congress of Americanists to be held in the City of Mexico, in September, 1910, Professor Frederick W. Putnam, of Harvard University.

Director L. H. Bailey, of the College of Agriculture of Cornell University, is at present in Great Britain.

The American Electrochemical Society is holding this week its seventeenth general meeting at Pittsburgh. The address of the president, Dr. Leo H. Baekeland, is on "Science and Industry."

At the annual meeting of the Iron and Steel Institute, May 4 and 5, Sir Hugh Bell resigned the chair to the Duke of Devonshire. The Bessemer gold medal for 1910 was presented to Mr. E. H. Saniter, and the president delivered his inaugural address.

Dr. L. A. Bauer gave the following lectures on terrestrial magnetism and atmospheric electricity at the Johns Hopkins University from April 25 to 29:

"The Chief Facts of the Earth's Magnetic Changes (Regular Variations and Magnetic Storms)."

"The Ionic Theory of the Earth's Magnetic Disturbances."

"The Earth's Magnetic Permeability and General Theory of Magnetic Variations."

"Relation between Terrestrial Magnetism, Solar Activity, Atmospheric Electricity, Radioactivity, Meteorology and Geology."

Nature quoting from the *Daily Chronicle* states that a monument in memory of Professor Tyndall will be erected on the summit of the Bel Alp, 6,735 feet high, a little above the place where for many years Tyndall resided during the summer months. Mrs. Tyndall has engaged M. F. Correvon, of Geneva, to design the monument, which is a large conical block of granite. It will be erected by the Swiss Alpine Club in July on Bel Alp, overlooking the Aletsch Glacier.

We learn from the *Journal* of the American Medical Association that at Jefferson, Ga., on April 21, a monument to Dr. Crawford W. Long was unveiled in the presence of members of the Medical Association of Georgia, which was in session at Athens. The monument is in commemoration of the fact that Dr. Long was one of the first to use ether as a general anesthetic. Dr. Woods Hutchinson, of New York, was the principal speaker.

The death is announced of Dr. George Carpenter, editor of the British journal of chil-

dren's diseases and a well-known authority on this subject.

THE Congress of American Physicians and Surgeons is meeting in Washington this week. Meeting in affiliation with it are the American Association of Genito-Urinary Surgeons, American Association of Pathologists and Bacteriologists, American Climatological Association, American Dermatological Association, American Gynecological Society, American Laryngological Association, American Medico-Psychological Association, American Neurological Association, American Ophthalmological Society, American Orthopedic Association, American Otological Society, American Pediatric Society, Association of American Physicians, and American Surgical Association.

THE British *Medical Journal* states that Professor Lannelongue, of Paris, has written to the Société de Chirurgie announcing his intention of founding a prize consisting of a gold medal carrying with it a sum of £250, to be awarded to the candidate who has contributed most to the progress of surgery during the ten years before the date of award. The prize is open to surgeons of all nations, and will be awarded every five years during the annual meeting of the Paris Société de Chirurgie. The judges will be a committee of surgeons of various nationalities, grouped as follows: The United Kingdom; Germany; Austria-Hungary and the Balkan States; Belgium, Holland and Scandinavia; Spain, Portugal and Mexico; United States and Canada; South America; Japan and China.

THE Naples Table Association for Promoting Laboratory Research by Women announces the offer of a fifth prize of one thousand dollars for the best thesis written by a woman, on a scientific subject, embodying new observations and new conclusions based on an independent laboratory research in biological, chemical or physical science. The theses offered in competition are to be presented to the executive committee of the association and must be in the hands of Mrs. Ellen H. Richards, Massachusetts Institute of Technology, Boston, Mass., before February 25, 1911. The papers will be judged by a board of examiners, or by such specialists as they may choose. The Board of Examiners consists of Dr. William H. Howell, Dr. Theodore W. Richards and Dr. Albert A. Michelson. The first prize was awarded to Florence Sabin, B.S., Smith, '93, M.D., Johns Hopkins University, '00, for a thesis on the "Origin of the Lymphatic System." The second prize was awarded to Nettie M. Stevens, B.A., M.A., Leland Stanford University, '99, '00, Ph.D., Bryn Mawr, '03, for a thesis on a "Study of the Germ Cells of *Aphis rosea* and of *Aphis œnotheræ.*" The third prize offered was not awarded. The fourth prize was awarded to Florence Buchanan, D.Sc., Fellow of University College, London, for a thesis on the "Time Taken in the Transmission of Reflex Impulses in the Spinal Cord of the Frog."

A LETTER has been received at the Harvard College Observatory from Professor Robert W. Willson, of Harvard University, stating that Halley's comet was photographed by Dr. J. C. Duncan at the Students' Astronomical Laboratory of Harvard University, April 21^d $3^h\,51^m$ A.M. eastern standard time. "Exposure 15m., considerably fogged by dawn. Comet brighter, photographically, than B.D. $+6''.5227$, mag. 4.4. Tail faintly seen to a distance of one degree; leaves read between two short, well-defined streamers whose position angles are 66 and 142 degrees. Pos. Ang. of axis of main tail, 100 degrees." A photometric measurement of the light of the nucleus of Halley's comet was made by Professor Wendell at the Harvard College Observatory on April 27. The comparison star was B.D. $+7''.5101$, phot. magn. 6.74. The measured brightness of the nucleus was 6.01 magn. The comet was visible to the naked eye. Its total brightness was estimated as 3.0 magn., or brighter, and the tail as over 3° long. The comet was observed visually on April 27 by Mr. Leon Campbell, who saw it easily with the naked eye and estimated its total brightness, by the Argelander method, as 2.5 magn. He estimated the tail as 4° in length. A photograph of the comet was ob-

tained at the observatory on the same morning. On the photographic plate, the comet shows a rather sharp nucleus with a short tail.

AN excursion for geological and geographical field work was recently made to the district between the Hudson River and the Catskill Mountains, with headquarters at Catskill, N. Y., by a party of thirty teachers and students from Harvard, the Massachusetts Institute of Technology, Yale, Columbia, St. Lawrence and Rutgers. The district visited is of particular value from its succession of fossiliferous formations, its folded and faulted structure, and its characteristic Appalachian topography, both structure and form being developed on a small scale that is especially suitable for purposes of instruction. Among the instructors present were Professors Davis and Johnson and Mr. Lahee, of Harvard; Professor Shimer, of the Massachusetts Institute of Technology; Professor Chadwick, of St. Lawrence; Mr. Hyde, of Columbia, and Professor Lewis, of Rutgers. Detachments of the party, first led by Professor Chadwick and later led by Professor Johnson, ascended the strong east-facing escarpment of the Catskill mountains, with special attention to the features of stream capture as determined by the retrogressive erosion of the east-flowing Kaaterskill Creek in its deeply incised clove, under the broad high-standing valley of the west-flowing Schoharie Creek.

THE commission on phytogeographic nomenclature appointed by the second International Botanic Congress, held in Vienna in 1905, and of which Professor John W. Harshberger, of the University of Pennsylvania, is the American member, has printed its report in a pamphlet of forty pages. This report is the joint work of Briquet, Geneva; Adamovic, Vienna; Beck von Mannagetta, Prague; Drude, Dresden; A. Engler, Berlin; Flahault, Montpellier; Harshberger, Philadelphia; C. Schröter, Zurich; W. G. Smith, Edinburgh; Warburg, Berlin; Eug. Warming, Copenhagen; and it will be presented with recommendations to the third International Botanic Congress, to be held in Brussels, from May 14 to 22, 1910.

THE American Phytopathological Society has passed resolutions as follows:

Resolved, That the American Phytopathological Society views with alarm the recent introduction into America of two dangerous European plant diseases: the potato wart, caused by *Chrysophlyotis endobiotica* Schilb., and the blister rust of white pine, caused by *Peridermium strobi* Klebahn. The former has been discovered in New Foundland. The latter has been widely distributed in nine of the United States and in the Province of Ontario, but is now believed to have been eradicated.

Resolved, That the society deplores the fact that in the absence of any national regulation in either the United States or Canada both governments are powerless to prevent the continued introduction of these and other dangerous diseases, or their transference from one country to the other.

Resolved, That on account of the enormous financial interests involved in potato culture and in white pine reforestation, this society regards the situation as very alarming, and one which warrants radical and immediate action. Even if these diseases do no more harm in America than they have in Europe, the situation is serious; but every law of biology and all experiences with plant diseases and pests indicates that, in a new climate, with new varietal and specific hosts and with an entire continent in which to spread, both diseases will reach a degree of virulence unknown in Europe.

Therefore, *Resolved*, That this society pledges its support to all legislation in both the United States and Canada looking toward the inspection, quarantine, or prohibition from entry, as may be necessary, of all plant material liable to introduce these or other dangerous diseases or pests.

SOME facts are being brought out by investigations of the effect of high voltages on insulating material by Mr. H. S. Osborne who is carrying out work for the degree of doctor of engineering at the Massachusetts Institute of Technology. At a recent meeting of the Boston Section of the American Institute of Electrical Engineers, which was held at the electrical engineering laboratories of the Institute of Technology, Mr. Osborne lectured on the results of his experimental research. The lectures of Professor Harold Pender for graduate students will next year extend the

discussion contained in his advanced lectures of this year on the high voltage alternating transmission and utilization of power. Professor Jackson's lectures for graduate students on the organization and administration of public service companies have this year dealt more particularly with questions of value of plant, the theory of so-called intangible values, the relation of revenues to value of the plant, depreciation, and the like; and next year the lectures will be directed more to the theory underlying methods of charging for service by public service companies, with particular reference to charges for electric light and power, but with collateral consideration of railroad and tramway charges and charges for gas and the service of other public utilities. Professor Wickenden will give a course of lectures on illumination, photometry and illuminating engineering which will become a part of the optional curriculum for undergraduate and graduate students.

Mr. L. L. Hutchison, assistant director of the Oklahoma Geological Survey, has sent to press a special state report on the asphalt, oil and gas deposits of Oklahoma. In part one is a general map which shows that portion of the state in which asphalt occurs and the region where it is likely to be found. It also contains a geological map of the asphalt bearing district, and one showing the exact location of nearly one hundred known deposits. Part two is devoted to oil and gas. After reviewing the history of the industry and discussing the various theories of origin and accumulation of petroleum and natural gas, Mr. Hutchison discusses the geology of the Oklahoma petroleum and natural gas fields and closes the work with a chapter devoted to the latest Oklahoma statistics and a review of past and present conditions in the field. This section of the report is illustrated by a general map showing the present developed areas, probable territory yet undeveloped, and those parts of the state where it seems possible that oil and gas may be found and by a geological map of the oil fields and detailed maps, on a scale of one inch to the mile, which give the location of every well drilled in the various important fields prior to 1910.

The Connecticut Agricultural College and the Willimantic State Normal School will hold their summer schools in the buildings of the State Agricultural College at Storrs, Conn., July 5–July 29, 1910. The Agricultural College offers courses in bird and insect study, botany, dairy industry, animal husbandry, school gardening, fruit culture, floriculture, landscape gardening, soils, farm crops, practical cooking, a special four-weeks' course in practical poultry husbandry, and a course in elementary agriculture with a model country school showing how agriculture may actually be taught in the schools. The Normal School offers courses for teachers in arithmetic, civics, geography, history, language, methods in rural schools, penmanship, psychology and reading.

Professor J. W. H. Trail, F.R.S., recently offered to the council of the Linnean Society a sum of money for the purpose of encouraging the study of protoplasm by means of an award to be made periodically, and, as we learn from *Nature*, a special medal has been struck in bronze for presentation with the award, bearing on the obverse a portrait of Linnæus and on the reverse the words "Trail Award" and the name of the recipient in a wreath. It is proposed to make an award about once in every five years for original work bearing directly or indirectly upon the "physical basis of life," and, in accordance with the wishes of the donor, a wide interpretation will be given to the scope of the investigations. The first recipient of the award will be Professor E. A. Minchin, professor of protozoology in the University of London, whose researches on sponges and protozoa have done so much to advance our knowledge of protoplasmic structures, and who is also the translator of Professor Bütschli's well-known work on protoplasm.

UNIVERSITY AND EDUCATIONAL NEWS

More than $2,000,000 has been contributed to Washington University, St. Louis, for the medical department. The donors are Messrs. William K. Bixby, Adolphus Busch, Edward Mallinkrodt and Robert S. Brookings. Added to this are the resources of Barnes

University, recently absorbed; the Martha Parsons Hospital and the original endowment fund of the university. New appointments have been announced as follows: Dr. George Dock, of Tulane University; Dr. John Howland, of the University and Bellevue Hospital Medical College; Dr. Eugene L. Opie, of the Rockefeller Institute for Medical Research, and Dr. Joseph Erlanger, of the University of Wisconsin. Construction of new buildings, to cost more than $1,000,000, will begin at once.

By the will of Stanley O. Thomas, recently probated, Tulane University received a legacy of $60,000, to be used for the erection of a building.

Mr. R. A. Booth will give the Williamette University, of Salem, Ore., $100,000 as an endowment fund on the condition that the institution raises $300,000 more from other sources.

Acting upon the suggestion of representatives of the Carnegie Foundation, plans are being completed to merge the medical school of Ohio Wesleyan University with that of Western Reserve University, both of which are located in Cleveland. The students and part of the faculty of the College of Physicians and Surgeons will by this consolidation be transferred to the Western Reserve Medical School, while Ohio Wesleyan University, of which the College of Physicians and Surgeons now is a department, will sever all connections with the Cleveland school.

At the annual business meeting of the board of regents of the University of Wisconsin Eric W. Miller, of the U. S. Weather Bureau station at Madison, was made lecturer in meteorology; Professor J. D. Phillips, of the engineering drawing department, was made assistant dean of the college of engineering; Max Mason was promoted to be professor of mathematical physics from an associate professorship of mathematics. The following were promoted from assistant professor to associate professor: E. B. Skinner, in mathematical physics; L. R. Ingersoll, in physics; E. V. McCollum, in agricultural chemistry, and J. G. Moore, in horticulture. Promotions from the instructor to assistant professor were made as follows: C. A. Fuller, in bacteriology; W. J. Mead, in geology; H. C. Wolff, in mathematics; W. H. Brown, in pathology; E. M. Terry, in physics; W. J. Meek, in physiology; W. E. Tottingham, in agricultural chemistry; E. J. Dolwiche and A. L. Stone, in agronomy; G. H. Benkendorf, in dairy husbandry, and J. H. Price, in electrical engineering.

At Columbia University Dr. Edward Kasner has been promoted to a professorship of mathematics, Dr. Russell-Burton Opitz, to be associate professor of physiology and Dr. Raymond C. Osburne to be assistant professor of zoology in Barnard College.

Dr. R. DeC. Ward has been promoted to a chair of climatology at Harvard University.

Recent additions to the faculty of the University of North Dakota are George Alonzo Abbott, Ph.D. (Massachusetts Institute of Technology), professor of chemistry, and Bartholomew J. Spence, Ph.D. (Princeton), assistant professor of physics.

Mr. J. A. Smith has been elected to the Waynflete chair of moral and metaphysical philosophy in the University of Oxford, to fill the vacancy caused by the resignation of Professor T. Case.

DISCUSSION AND CORRESPONDENCE

THE UNIVERSITY OF MINNESOTA AND THE CARNEGIE FOUNDATION

To the Editor of Science: The following report from the *Minneapolis Journal* of speeches made after a dinner of the Faculty Club of the University of Minnesota has been corrected by the speakers and is forwarded to Science for publication. The resolutions referred to have been prepared by the executive committee and forwarded to the trustees of the foundation. X.

University of Minnesota,
April 29, 1910

Decided protest against the action of the trustees of the Carnegie Foundation in substituting complete disability for the twenty-

five-year service period was made by the members of the Faculty Club of the University of Minnesota at its dinner last night. After a series of spirited talks the executive committee was requested by formal motion to prepare resolutions expressing the sentiments of the club and to forward them to the trustees.

Professor John J. Flather, head of the mechanical engineering department, who presided at the dinner, opened the discussion with a brief but complete history of the establishment of the Carnegie Foundation for the Advancement of Teaching.

Mr. Flather devoted much of his address to the clause which grants a pension to professors in accepted institutions who have had a service of twenty-five years. This rule has been so changed that it will only apply to those who are unable to continue their work through disability.

Mr. Flather said on this point: "Surely, there is no justification for the statement that it was believed that the number of teachers who would avail themselves of retirement under the service provision would be confined almost exclusively to those physically impaired.

"Under the provisions of the foundation a teacher, after twenty-five years of service as a professor, was certainly entitled to retire without having his motives questioned. The recent action of the board is an unjust reflection upon every professor who has accepted the benefits of the foundation under the service requirements, and in consequence will be resented by every fair-minded person.

"If the Carnegie Foundation is to advance the cause of education in what better way can the funds be used than to retire certain teachers after long and meritorious service? If a man has lost interest or is worn out by the many demands upon his energies after a service of thirty to thirty-five years, why is it not wise to retire him after such service instead of waiting until he breaks down altogether, or until he reaches the age of 65 years. Most men will desire to teach until the age limit is reached. Why not, therefore, allow the lesser number to retire if thereby the cause of education will be advanced?

In order to ascertain why college teachers retire Dr. Pritchett sent letters to all teachers on the retired list. From those who had retired below the age of 65, after twenty-five years' service in the grade of professor, forty-two letters were received. Of these twelve had retired on the ground of impaired health; ten retired on account of some college complication, the resignation of one half of the number having been requested. Of the remaining twenty, five desired to engage in research or other professional labor, two took advantage for family reasons; two thought that younger colleagues ought to have the chance to occupy the position they held; five desired to engage in business; six desired recreation and relief from the recitation and lecture room.

The average length of service of all the men from accepted institutions who have been retired to date is practically thirty-five years, and the average age at retirement 60 years.

The rules amended by the board of trustees in accordance with the recommendations of its president, provide a retiring allowance for a teacher on two distinct grounds: (1) to a teacher of specified service on reaching the age of 65; (2) to a professor after twenty-five years of service in case of physical disability, or thirty years as professor and instructor together.

"Although these are the general rules governing retirement, the trustees are nevertheless willing to grant a retiring allowance after the years of service set forth in Rule 1 to the rare professor whose ability for research promises a fruitful contribution to the advancement of knowledge if he were able to devote his entire time to study or research; and the trustees may also grant a retiring allowance after the years of service set forth in Rule 1 to the executive head of an institution who has displayed distinguished ability as a teacher and educational administrator.

"There seems nothing incompatible with the dignity and right of a teacher in retiring for the reasons above assigned. The foundation is not a charity; the retiring allowance is a part of the regular academic compensation and if there is any merit in the service pen-

sion it should not be dependent upon the disability of a professor, nor contingent upon his ability or willingness to become the head of an institution.

"The action of the board in peremptorily abrogating one of the two specific objects of the foundation, is justly looked upon with great disfavor by a large body of men engaged in college teaching, nor can it be justified by the arguments advanced. The system has not been working a sufficient length of time to frame accurate conclusions or to draw inferences which would warrant such drastic measures."

Professor Henry J. Fletcher, of the law school, in discussing the legal aspects of the situation, spoke as follows:

"The Carnegie Foundation is now organized under an act of Congress. It is the trustee of an express trust. It holds a fund the income of which is to be distributed among beneficiaries. These beneficiaries were not named by the founder, but the 25 men selected as trustees (who have now incorporated themselves) were authorized to designate beneficiaries. They have done this, not by name, but by defining classes of persons. When trustees, in addition to their ordinary duties as trustees, are empowered to name the beneficiaries of a trust which they are to administer, and they do name them, a named beneficiary becomes the owner of a definite enforceable, equitable interest in the fund. This equitable interest, so fixed, is vested; it is property; it can not be destroyed by a revocation of the designation, either by the action of the trustee alone, or by the trustee and founder acting together, unless the right of revocation has been reserved. If acting under the authority of the deed of trust, the trustees, instead of naming beneficiaries, define a class, all of whose members are declared to be entitled to participate in the fund as beneficiaries, each individual member of the class has exactly the same rights as if he had been named.

"As I understand the facts, the trustees of the Carnegie Foundation defined two classes: First, those professors in accepted institutions who should have served 25 years—service already performed to count toward the period designated; second, those professors in accepted institutions who should continue in the service until they reach the age of 65 years. If the principles outlined above are correctly stated, professors belonging to the first class who at the time of the announcement were engaged in the designated class of work in accepted institutions, and were therefore eligible to a pension on completing the required period of service, have a vested property interest in the fund, subject to be defeated only by their failure to remain in the class for the requisite length of time. For example, if a professor were designated by name, and informed that he was eligible to the service pension on condition that he continue in service until he shall have taught 25 years, his rights would thereby become vested. If, instead of being named, he were a member of the first class, the case would be the same. His rights could no more be destroyed without his consent than the rights of the beneficiary under a life insurance policy can be cut off without his consent prior to the death of the life-insured. If the trustees have the power to annex new conditions to the receipt of a pension by members of the first class, they can cancel the designation of that class entirely; and if they can drop the first class, they can drop the second as well; they can abandon the present plan and adopt a new one, with wholly different beneficiaries.

"The only theory under which the trustees can claim a legal right to change beneficiaries at pleasure is, that the trust is a charity, or that the right to change has been expressly reserved. A charitable trust does not require, nor permit, definite beneficiaries. No individual can claim the enforcement of a charity in his behalf. But the trustees of the Carnegie Foundation have taken especial pains to make it certain that this is not a charitable trust. They have declared that the pensions to be paid are payments for services rendered, to which the recipients are to be entitled as of right, and not as a charity. If that is true, any man who entered the class before the trustees declared their intention to practically

abolish it, has rights enforceable in a court of equity. Were it not for repeated declarations of the trustees to the contrary, I should be strongly disposed to think the trust charitable. The courts would of course not be bound to adopt the view of its character now taken by the trustees, and the trustees may hereafter themselves think differently. Their recent change of attitude suggests that possibility. If unforeseen exigencies should compel them to take the position that the trust is after all in the nature of alms, very likely the courts would sustain them. A recipient of charity takes what he can get, not by right, but by grace.

"I assume, then, that the trust is non-charitable. It is true the trustees reserved the right to change their rules governing the details of administration; but obviously that has no reference to the abolition of a class already designated, so as to destroy vested interests. The articles of incorporation empower the trustees 'from time to time to modify the conditions and regulations under which the work shall be carried on,' and, by a two-thirds vote, to 'enlarge or vary the purposes' of the gift. This no doubt permits the door of entrance into either class to be closed at the discretion of the trustees; such action operates prospectively; but it is seriously doubted that the trustees by this clause reserve the power to cut off persons who are already in, and this includes all teachers and others of professorial rank who prior to the date of change in rule two were employed in accepted institutions."

Dean George F. James, of the College of Education, continued the discussion somewhat as follows:

"All of us remember with what pleasure we heard of Mr. Carnegie's gift for the advancement of university teaching. The general plan seemed to hold large promise for the improvement of higher institutions through better provisions for the teaching force. When the trustees later announced their plans in detail, the establishment of a service pension appeared from many points of view even more important than the accompanying arrangement of a retiring annuity at the age of sixty-five. As the trustees went on with their work and issued one report after another, proving the gradual acceptance by our colleges and universities of a uniform standard of entrance requirements and a minimum requirement in equipment, productive funds, and other conditions of efficiency, we became each year more convinced of the broad usefulness of the foundation.

"When the trustees suddenly disavowed one of the two main principles first adopted in respect to pensions, the announcement came as a distinct shock, not merely on account of the direct and immediate consequences, but even more on account of the uncertainty which might attach itself to the whole scheme of the foundation owing to this radical change of policy. The trustees had themselves on many occasions implied that of the pension system inaugurated by the foundation, the two best characteristics were the implicit confidence which beneficiaries might put in the consistent execution of the plans adopted, and the sense of right rather than favor which would be associated with each annuity granted. The first characteristic is largely eliminated by the sacrifice by the foundation of one important principle without any convincing statement as to either the advisability or the necessity of the action. The second characteristic on which the trustees have laid much stress can hardly be preserved, and professors in accepted institutions can hardly look upon the pension as a right rather than a charity, in view of the very serious strictures made by the president in the last annual report on a majority of the men who have so far retired on a service pension. The impersonal relationship which the trustees so properly emphasized as desirable between the foundation and the men retired under its provisions is thus very suddenly and vitally modified, with a resulting imminent danger that the attitude of university teachers the country over toward the foundation may no longer be as cordially sympathetic as hitherto.

"The problem of age and service pensions

under the foundation is sufficiently large and weighty so that no extraneous question should be brought into this discussion, but most of you must have observed with considerable interest, if not apprehension, the view adopted by a sister state in respect to private benefactions and the resulting indirect private control over public institutions. The plans of the Carnegie Foundation have commended themselves to us all, and the mode of procedure under these plans has, up to the present, been susceptible of no serious objection from the institutions which are cooperating or from the general public. Nevertheless, a very large element in public opinion is doubtful of the desirability of subjecting public education to any form of corporate influence which is not itself responsive to public opinion. Lest this feeling should grow so as to jeopardize the usefulness not only of this but of many instances of private benefaction, the trustees of the Carnegie Foundation, in the judgment of many disinterested and sympathetic observers, should be very much on their guard against any apparent transcendence of their real functions. In a recent report of the foundation a proof may be found of the delicate nature of the ground on which the foundation is treading in its official publications. Broad questions of educational administration must be to some extent raised and discussed in connection with the immediate problems of the foundation itself, but that a decided attitude should be taken by its officers as regards a problem not vital to its purposes, as was done recently in the matter of federal appropriations to education, will seem to many an act of doubtful propriety, and likely to arouse criticism otherwise unnecessary, if not to bring about an attitude of real hostility on the part of the public toward the work of the foundation.

"In the situation which now presents itself, the trustees of the Carnegie Foundation will certainly welcome an expression of opinion from all of the accepted institutions cooperating in its work, and therefore a motion is herewith made that the executive committee of this organization, representing the different faculties of the University of Minnesota, be directed to submit to the executive committee of the Carnegie Foundation for the Advancement of Teaching that the service pension as originally planned and put into effect was one of the most admirable features among the many projected by the foundation; that the limitation now imposed is a serious impairment of its scope and nullifies very largely the beneficent object contemplated; that we sincerely regret the action of the trustees in their announcement of the practical withdrawal of such pension; that we deplore the lack of confidence which has resulted therefrom; and that in our opinion the service pension should be restored in a form not essentially different from its original."

In conformity with the above mentioned the executive committee will draw up a set of resolutions and forward the same to the trustees of the Carnegie Foundation at an early date.

SCIENTIFIC BOOKS

Précis d'Embryologie Humaine. Par F. TOURNEUX. Second edition. Pp. 589, 248 figures. Paris, 1909.

This work, like McMurrich's "The Development of the Human Body," is a text-book for the student of medicine. The two books have the same general character, being brief, concise and accurate statements of the outlines of human embryology. They are of almost the same size for, although the pages of the latter are somewhat larger, the smaller type of the former allows a greater compactness.

Tourneux has dispensed entirely with a bibliography, but has more than compensated for its absence by an historical treatment of the subject. Throughout the book he credits to each author, by putting his name and the date of the work in parentheses, his particular contribution to the subject. In this way the author succeeds admirably in giving the student an insight into the history of embryological research and in preventing him from feeling that the book is an ultimate authority.

The book begins with an introduction upon the history of embryology which the author divides into three periods: morphological, his-

tological and phylogenetic. He believes that the last period extends to the present time, but to the writer the interest in theories of vertebrate descent, and the belief that the "law of von Baer" can yield a fundamental conception of the history of animal forms, seem to have given place to the desire to understand the principles of growth and of inheritance.

The first chapter, upon the germ-cells, maturation, fertilization and segmentation, is of a general and comparative nature and includes an exposition of the theories of the significance of maturation and fertilization, and of the problem of heredity. It does not contain, however, any reference to Mendel's work or to that of his successors.

In order to have a consistent and continuous description of the early stages of development, Tourneux devotes a long chapter—slightly more than one sixth of the text proper—to a description of the history of the ovum of the rabbit up to the time of the establishment of the body-form. This account is very clear and convincing, and is particularly acceptable because the author does not interrupt its continuity by making a patch-work of fragments of the history of the ova of many vertebrates.

The third chapter, which completes the first part of the book, contains brief accounts of many of the best preserved early human embryos.

The second part of the book is divided into thirteen chapters, which may be subdivided according to size into three groups: those upon the digestive and urogenital systems are long, having 79 and 74 pages, respectively; those upon the nervous, locomotor and circulatory systems, and the fœtal envelopes are of moderate length, about 40 pages; and finally, those upon the respiratory system, suprarenal organs, the skin and upon the organs of taste, smell, sight and hearing are short. The treatment of the digestive and urogenital systems seems disproportionately long, and the section upon the voluntary muscles, consisting of about thirty lines in the chapter on the locomotor system, is ridiculously small. Otherwise the discussion of the several organs and organ systems is excellently proportioned. There is an index and an appendix upon the length of the period of incubation or of gestation in several birds and mammals.

The failure to adopt the Basle anatomical nomenclature, and even the occasional omission, in an extensive series of synonyms, of the name used in this nomenclature, seem to the writer to be the great fault of the book.

The figures, 248 in number, are well chosen and are excellently reproduced. The use of only a very few diagrams is commendable. The book deserves a thorough success.

Leonard W. Williams

Broad Lines in Science Teaching. By F. Hodson. New York, Macmillan Co. 1910. 8vo, pp. xxxvi + 267. $1.25.

This book consists of a series of essays by a number of writers, edited by Mr. F. Hodson, of the Bedales School at Petersfield, England. The papers all deal with the teaching of science to boys and girls of secondary school age; and the editor's object has been "to cover a wide field, to achieve, through variety of the contributor's experience, a variety of presentation, and so to convince the reader of the many-sided human value of science in modern education."

The introduction is by Professor M. E. Sadler, who calls attention to the necessity for a more careful study of the methods of teaching science. He says (p. xix):

> Science has secured a place in the curricula of the higher schools, a firm place and respectful recognition; but scientific method and the spirit of science have not yet influenced the whole of the intellectual life of the schools, have not yet remolded the ways of teaching in other than what, in the narrower sense of the words, are called scientific subjects.

He then reviews the essays that follow, and draws some general conclusions from the study of the entire collection. As distinct marks of successful teaching of science he mentions four as being most essential—an alert interest in things seen; patience and exactitude in observing, verifying and recording them; a disposition to brood over new

facts before reaching a judgment as to their meaning and classification, and an habitual willingness to take great trouble in getting at the truth.

The first essay is by Professor J. H. Badley on the Place of Science in the School Curriculum. He tests the value of science in education by "the kind of motive it appeals to and arouses, the kind of power it develops, and the kind of discipline it gives." He shows that, tested by these criteria, science has an important place in the schools.

The remaining essays in the book are as follows: The Scope of Nature Study, Edward Thomas; The Teaching of Nature Study, Clotilde Von Wyss; Biology in Schools, Oswald Latter; The Teaching of Hygiene, Alice Ravenhill; The Place of Hypotheses in Science Teaching, T. Percy Nunn; The Claims of "Research" Work and Examinations, Fred Hodson; School Mathematics in Relation to School Science, T. James Garstang; Coordination of Physics Teaching in School and College with Special Reference to Electricity and Magnetism, Alfred W. Porter; Geography, J. H. N. Stephenson; Science in the Teaching of History, F. M. Powicke; Economic Science in Secondary Schools, Augustus Kahn; Domestic Science, Arthur Smithells; The Teaching of Chemistry in Technical Schools, Henry Garrett; How the School may help Agriculture, E. W. Read; Engineering, An Associate of the Institution of Civil Engineers—Science Teaching and the Training of the Affections, Sidney Unwin; Science Teaching and a Child's Philosophy, Cora B. Sanders; The Present Condition of Physics Teaching in the United States, C. R. Mann; School Science in Germany, the Editor; Some Practical Notes on the Planning of Science Laboratories, T. H. Russell.

In the brief space of a review it is impossible to give any definite idea of the content and richness of these essays. They are all excellent and full of suggestion. Every one who is interested in the problems of science teaching on broad lines should read and study this book at first hand. It is an important contribution to one of the most pressing of our school problems of the present day.

C. R. MANN

THE UNIVERSITY OF CHICAGO

Design in Nature. By J. BELL PETTIGREW, M.D., F.R.S., 3 vols. New York, Longmans, Green & Co. 1908.

Dr. J. Bell Pettigrew, professor of anatomy and medicine in the University of St. Andrews, was more especially known for his contributions to mammalian anatomy and discussions on the physiology and mechanics of flight. He was not a skilled zoologist, in the sense of being an expert student of any particular group of animals; but he had a keen interest in nature and a wide, if somewhat shallow, knowledge of a great variety of subjects. Being firmly convinced that the order and beauty of the visible world bore eloquent testimony to the existence of an invisible but ever-present "creator, designer and upholder," he conceived the idea of preparing a work which should make this evident to every reader. The "argument for design" presented nothing new, of course; but never before had it been supported by such a wealth of illustrative facts, gleaned from the storehouses of modern science. Just as Darwin profited by the mass of data accumulated by those who knew nothing of evolution, now Pettigrew was to utilize the contributions of an unbelieving age, in support of the ancient doctrine of special creation. The work was finished, and partly printed, at the time of the author's death in January, 1908. It consists of three great quarto volumes, aggregating 1,416 pages, with innumerable illustrations. The printing and binding are excellent, and at the beginning of each volume is a portrait of the author. As is remarked in the preface, "it was necessary to deal with physics, chemistry, botany, zoology, anatomy, physiology, psychology and paleontology more or less in detail," but most space is given to the author's favorite subjects, vertebrate anatomy and animal locomotion. Those who have no sympathy with the main purpose of the work will find it a sort of glorified scientific scrap-book, full of entertaining and instructive matter. It does not

contain a closely reasoned philosophical argument, but naïvely assumes that there can be only one logical explanation of the facts presented, and consequently the case becomes stronger in proportion to the data accumulated. This is of course the attitude of the modern evolutionist, only his explanation is not quite the same. The wonders of adaptation, the community of general structure in series of animals, the facts of paleontology, all are brought forward as evidence of intelligent design. If two pictures or statues show points of resemblance we do not say that they are derived one from the other, but we may suspect that they were created by the same hand. Just so Dr. Pettigrew, and having got thus far, the very difficulties in the way of the creation hypothesis appear to lend it support. For example, take any remarkable case of adaptation; the naturalist may show that a particular species is able to flourish at a particular time and place, because of a multitude of circumstances, *all* of which are more or less essential to its prosperity. It would not be sufficient merely to create the animal, it must be exactly so, at exactly such a place, with all the other characters in the play doing their proper parts. Quite impossible! you say. On the contrary, it is such a marvelous thing that it *proves* the action not merely of intelligence, but of the highest conceivable kind! The trouble is, that it not only requires the highest conceivable intelligence, but a still higher and wholly *inconceivable* sort. It transcends physics and metaphysics, and lands us in the field of metapsychics. In other words, the "explanation" is no explanation at all, and serves merely to shelve the question of origin and sequence. The author, at the end of each discussion, turns around to his audience and asks, like the conjurer, who can explain the trick except in his way; but also like the conjurer, he refrains from telling us precisely what that way is. There is no reason to suppose that this ardent supporter of "creation" had or pretended to have the least idea of the nature of the process.

Although our criticism is adverse, we must confess to a certain sympathy with the author. Evolution is not a key to unlock every door of mystery. We who are concerned daily with the mechanics of life need to be reminded from time to time that there are more dimensions of reality than those in which we quarry. It is not for us to claim that we really understand, in any complete sense, how this world of ours came to be what it is. As scientific men, however, we are bound to reject mere dummy explanations of things, mere words which embody no rational thought; and by the same token, we must hold fast to those facts and theories which seem to be best verified by experience. The theory of organic evolution, full of difficulties as it is, has some substance, some genuine pragmatic ability; that of creation, as held by Dr. Pettigrew, is but a shadow of a shadow. To our posterity five hundred years hence it will doubtless seem that we were groping in the dark; but let it be at least said of us, that we groped to the best of our ability.

T. D. A. COCKERELL

Bulletin of the American Museum of Natural History, Vol. XXVI.

This volume of contributions from the scientific staff of the American Museum of Natural History appears less interesting than its predecessor, though it attains a generous size of 430 pages, and contains twenty-nine articles from the pens of seventeen contributors. The articles of discussional and narrative value are fewer in number, and the volume is more confined to systematic studies.

Perhaps, from the point of view of general utility and interest, Mr. A. Hermann's demonstration of "Modern Laboratory Methods in Vertebrate Paleontology" most quickly attracts attention. The article can not be impugned on the score of paucity of detail. It makes indeed an excellent manual of direction for all museums of vertebrate fossils, and commands deference from the place its author holds among preparators. It is also in a measure, and quite frankly, a history of progress.

The papers on fossil vertebrates open with an article on the genus *Ancodon* by Dr. Mat-

thew. It announces the discovery of this pig-like genus in the Miocene of North America (hitherto confined to the Eocene and Oligocene), and, in an interesting paragraph, sums up the present views of the author as to its evolutionary history:

> On present evidence we must regard the genus as of Old World origin, probably not African, possibly European, but, considering the relative advancement and geological position of the European and African species, more probably of Asiatic origin.

Dr. Matthew contributes (in collaboration with Harold J. Cook) another paper on "A Pliocene Fauna from Western Nebraska," of which the remarkable features are thus summarized; the separation of fifty species allied to those of the Upper Miocene, but differing (1) in the presence of more advanced species or mutations, (2) Pleistocene or modern genera not hitherto reported from the Tertiary, (3) abundance of three-toed horses resembling the pleistocene *Equus* and *Hippidion*, (4) the remains of gigantic camels of the genus *Pliauchenia*.

Professor Osborn furnishes a paper on "New Carnivorous Mammals from the Fayum Oligocene of Egypt," in continuation of his previous studies on this fauna. The new genus *Metasinopa* is diagnosed from "a nearly complete lower jaw from the upper beds."

Dr. L. Hussakof discusses further the vexed question of the systematic relationship of American Arthrodires, and deposes Eastman's genus *Protitanichthys*. Roy L. Moodie, of the University of Kansas, contributes a paper on "New or Little Known Forms of Carboniferous Amphibia in the American Museum Collections."

Nine articles of varying interest in mammalogy are contributed by L. S. Quackenbush, John T. Nichols, Dr. Allen, Roy C. Andrews and Dr. Elliot. The most extended of these is an account by Dr. Quackenbush of the "Alaskan Mammoth Expeditions in 1907 and 1908." A feature of Mr. Andrews's paper is the photographic reproductions of whales, "sounding," the "slick," inspiration, "lobtailing," thrashing, diving and spouting.

Mr. Bentenmüller adds five articles, with plates, to his previous papers upon gall-insects. Professor Cockerell discusses the "Fossil Insects of Florissant, Colo."; James A. G. Rehn contributes a long paper (31 text figures) upon the "Orthoptera of Sumatra"; Professor Wheeler is represented by an article upon the "Ants of Formosa and the Philippines," and Aaron L. Treadwell has a note upon an external parasite of eunicidian worms, taken in the Bahamas.

Two remaining papers have considerable value, one by Walter Granger, on the "Faunal Horizons of the Washakie Formations of Southern Wyoming," and some suggestive paragraphs by Dr. W. J. Sinclair on the "Washakie or Volcanic Ash Formation." The summary of the latter comprises a number of informing statements which deserve entire transcription:

> The Bridger rocks are rhyolitic tuffs containing glassy sanidine while the Washakie rocks are andesitic with soda-lime feldspar. From the absence of agglomerates and the fine-grained character of much of the ash it seems probable that it was transported mainly by the wind, and as the prevailing winds are at present from the west and had probably the same direction in Tertiary time, the centers of eruption should be located somewhere in the west or southwest. The absence of agglomerates does not favor the idea of local contemporaneous vents discharging rhyolitic and andesitic ash respectively and the great thickness and uniform petrographic character of each formation is opposed to the conception of rapid variation in the chemical composition of the ash at a single center of eruption. Assuming contemporaneous deposition from two centers of eruption it seems probable, in view of the comparatively short distance separating the areas occupied by the two formations (about fifty miles) that some intermixture of the two types of ash should be found, but the conspicuous absence of plagioclase feldspar from all the Bridger tuffs, and its presence in all those of the Washakie shows that this has not occurred. The lithologic evidence, therefore, does not favor the idea of contemporaneity for any part of the Bridger or Washakie.

Professor Osborn in 1881 upon faunistic evidence had indicated their probable separation.

L. P. GRATACAP

BOTANICAL NOTES

A VERY ANCIENT SEED

WHAT is called "the most primitive seed that has yet come to light" is described by Professor F. W. Oliver in the *Annals of Botany* (Jan., 1909) under the title "On *Physostoma elegans*, an Archaic Type of Seed from the Palaeozoic Rocks." It was first discovered in 1875 by the late Professor Williamson in the Lower Coal Measures of Lancashire, England, who gave it the name used above. In size it is quite small, being from tip to tip only 5.5 to 6 millimeters long. Its integument is ribbed, and at the level of the top of the nucleus the ten ribs become so many separate arms which project beyond the nucellus for a considerable distance. Many pollen cells were found, and these have been sectioned and studied to such good purpose that what appear to be fossil sperms (spermatozoids) have been made out. These are flattened oval bodies occurring in pairs in each pollen cell. That we now calmly accept these results of Professor Oliver's study of these ancient seeds shows what tremendous progress has been made in our knowledge of the general cycad type of seed apparatus, and we even scarcely smile at the author's somewhat naïve statement that "no appendages or cilia have been detected in connection with these bodies" (*i. e.*, the sperms)! The plants that bore these interesting seeds have not yet been traced, but the author refers them provisionally to the Lyginodendreae of the Pteridospermeae (Cycadofilices), and they are without doubt among the earliest of seed-producing plants.

CYTOLOGICAL PAPERS

WE can do little more than to enumerate the titles of the cytological papers that lie before us, beginning with "The Stature and Chromosomes of *Oenothera gigas*" (*Archiv für Zellforschung*, Bd. 3, 1909) by R. R. Gates, reaching among others the conclusion that closely related species of plants may differ in the number of chromosomes.—In a concisely written paper, "Cytological Studies on *Oenothera*" (*Ann. Bot.*, Oct., 1909) Dr. B. M. Davis adds many details, by the critical study of the pollen development of *Oenothera grandiflora*.—Other mainly or wholly cytological papers by the same author are "Polar Organization of Plant Cells," "Some Recent Researches on the Cilia-forming Organ of Plant Cells," "Apogamy in the Ferns," "The Origin of Archegoniates," "The Permanence of Chromosomes in Plant Cells," all of which appeared in the *American Naturalist* during the past year or two.—Edith Hyde contributes her mite to the cytological treasury in a paper on "The Reduction Division in the Anthers of *Hyacinthus orientalis*," in the *Ohio Naturalist* for June, 1909.—"The Embryo Sac of Habenaria" (*Bot. Gaz.*, Oct., 1909) has been carefully studied by W. H. Brown, adding to our knowledge of the embryo sac and the early stages of the embryo. —Professor Schaffner contributes a valuable paper on "The Reduction Division in the Microsporocytes of *Agave virginica*" (*Bot. Gaz.*, March, 1909) bringing out the successive steps in the process.—Dr. A. A. Lawson's paper on "The Gametophytes and Embryo of *Pseudotsuga douglasii*" (*Ann. Bot.*, April, 1909) leads him to the conclusion that "this genus is not closely related to *Tsuga*," and that "the view that the Abietineae are the most ancient group of the Coniferales is very much strengthened."—A careful cytological study of the "Microsporophylls of Gingko" (*Bot. Gaz.*, Jan., 1910) by Anna M. Starr shows that the microsporophylls are in strobili that develop acropetally, with suggestions that they may have come "from a peltate type like the microsporophylls of *Taxus*."

SUMMER LABORATORIES

IT is not too early for botanists to be planning for their summer outing and study, and so a notice of the prospectuses of waterside and mountain laboratories at this time is not out of place.

The Marine Biological Laboratory at Woods Hole, Mass., offers again courses in Plant Structures and Responses, Morphology and Taxonomy of the Fungi (by Dr. Duggar) besides the usual facilities for research work. It opens June 29 and closes August 9. Dr.

George T. Moore, of the Missouri Botanical Gardens, St. Louis, Mo., is in charge of this work.

The Biological Laboratory at Cold Spring Harbor, Long Island, announces courses from July 6 to August 16, in Cryptogamic Botany, and Ecology, as well as opportunities for investigation. Professor D. S. Johnson, of the Johns Hopkins University, is in charge of the botanical work.

In the interior we have it announced that the second session of the Lakeside Laboratory at Lake Okoboji, Iowa, will extend from June 20 to August 15. Professor T. H. Macbride, Iowa City, Iowa, will be in general charge of the botanical work. Courses are offered in Mycology, the Biology of Aquatic Plants, the Nature of Plants, Histological Methods and Ecology, with opportunities for research work.

In the Rocky Mountains there will be continued from the middle of June to the end of July the University of Colorado Mountain Laboratory at Tolland, Colo., at an altitude of nearly nine thousand feet. Alpine problems will be given especial emphasis. The botanical work is in charge of Professor Francis Ramaley, Boulder, Colo.

PAPERS ON ALGAE

A VERY helpful paper entitled "Hints on Collecting and Growing Algae for Class Purposes," by Professor J. A. Nieuwland, appeared in the October (1909) *Midland Naturalist,* in which the author gives with considerable fulness his methods which he has found to be successful. He encourages us by saying that "as a matter of fact it is not especially difficult to obtain or even to grow the lower plants, and most of them once gotten are easier to keep a long time than the phanerogams." It will repay careful reading by every botanist who has before him the problem of obtaining and maintaining a supply of fresh material of the algae.

The same author in the same number of the journal mentioned ventures a new interpretation of the "knee joints" often observed in *Mougeotia,* namely, that these bendings are the first stages of the fragmentation of the filament, such fragmentation resulting in the formation of as many new filaments.

Ernst Hayren's paper on the "Algae of the Region of Bjorneberg" (in *Proc. Soc. Fauna et Flora Fennica*) is interesting because of the ecological notes that he manages to introduce. He includes observations on Chlorophyceae, Characeae, Phaeophyceae and Rhodophyceae.

"The Life History of *Griffithsia bornetiana*" is worked out in a paper in the October (1909) *Annals of Botany,* by I. F. Lewis. It is more than a report upon the structures which he found in his studies, for he has made it contribute to the discussion of the nature of alternation of generations. The conclusion is reached that in these algae "there is an antithetic alternation of generations, the gametophyte being represented by the sexual plants, the sporophyte by the sporogenous cells of the cystocarp." Five double-page plates beautifully illustrate the paper.

The unicellular fresh-water algae of the Dutch East Indies are described and figured in a recent paper by Dr. Ch. Bernard, and issued as Bulletin XXIV., of the Department of Agriculture at Buitenzorg. Our first remark is upon the significant fact of its issuance by a department of agriculture. Evidently the Netherlandish agriculturists take a very liberal view as to the matter for their bulletins. The desmids and many Protococcoideae are taken up in the paper, which is accompanied by six good plates.

Part I. of "The Marine Algae of Denmark," by L. K. Rosenvinge, has appeared as one of the memoirs of the Royal Academy of Sciences and Letters of Denmark. This part includes the introduction of about fifty pages, and about a hundred pages of descriptive text of Bangiales and Nemalionales. This text is well illustrated by text figures. Several maps and plates also accompany the present part. The work as a whole promises to be of great importance.

CHARLES E. BESSEY
THE UNIVERSITY OF NEBRASKA

THE WORK OF THE MARINE BIOLOGICAL STATION OF THE U. S. BUREAU OF FISHERIES, AT BEAUFORT, N. C., DURING THE YEAR 1909

A steam launch was available for a portion of the year for the use of the station. Another launch, equipped with a 9 H.P. gasoline engine, was available throughout the year, except for a brief period in the spring when it was detailed to the Edenton station. A large sailing-boat and a number of rowboats were also a part of the general equipment of the station.

A new 30 H.P. boiler was installed in the power-house. This furnished ample power for operating the electric-light plant and for supplying the station with running salt and fresh water. A mess was maintained from the latter part of June to the middle of September by the investigators and assistants. Board cost each member of the mess five dollars per week.

In connection with the experiments of Professor Binford an apparatus was installed for supplying the station with salt water at temperatures higher than that of the surrounding water in the harbor. The apparatus, while not perfected, was practicable, and it is available for similar experimental work in the future.

A large concrete pound, begun late in the previous year, was completed for carrying on experiments looking toward the culture of the diamond-back terrapin. The pound was so arranged as to give the terrapins free access to salt water, marshy land and sand. The experiments with the terrapins were begun too late in the season for securing as good results as would otherwise probably have been obtained. Eggs were laid, however, by the terrapins and a number of the young were hatched. Experiments were begun with a view of rearing the young. At the end of the year the experiments were being carried along successfully. Professor W. P. Hay, of Washington, D. C., had general supervision of the work.

What is planned to be a comprehensive study of the molluscan life of the Beaufort region, including a study of its general relation to the Transatlantic province, was begun with work on the lamellibranchs. Considerable dredging was done as well as other collecting from more accessible places. The material will be supplemented by collections made from the dredging done by the *Fish Hawk* off-shore near Beaufort in 1907.

A detailed study of the breeding habits of the common clam, *Venus mercenaria*, was begun. Work during the summers of previous years, principally by Dr. H. E. Enders, showed that the sexual elements were abundant during the summer season, but that the eggs could be fertilized only sparingly in the laboratory. Examinations made at intervals of about nine days each, beginning the early part of November, showed that eggs and active sperm were present both during November and December. Dr. Enders reached the conclusion that the breeding season of *Venus mercenaria* extends through several months, during which a small quantity of eggs is discharged at short intervals under natural conditions; and it may be that the spawning period extends throughout the year. The temperature, however, may prevent the development of eggs during the colder portions of the year.

The laboratory collection of fishes was increased by a gift of a number of specimens from Mr. Russell J. Coles, of Danville, Va. These specimens were collected from Cape Lookout in 1909. The collection included two specimens of *Narcine brasiliensis* (Ölfers), a species which, it is believed, has not heretofore been recorded from anywhere along our coast north of Florida.

The facilities of the station were utilized by a number of investigators, each working on problems related more or less closely to the work of the bureau. They have kindly furnished abstracts of their work, which are herewith included. They were:

Dr. H. V. Wilson, professor of zoology, University of North Carolina, Chapel Hill, N. C. Dr. Wilson studied the structure, behavior and regeneration of the epidermal layer in some monaxonid sponges (*Stylotella* and *Reniera*). The epidermis in these forms

was found to consist not of separate cells. It is a syncytial nucleated sheet of protoplasm without cell boundaries. The epidermis is regenerated over a cut surface in about twenty-four hours. The union of the mesenchyme cells to form it was followed. Some new facts as to the way in which pores close were made out.

Dr. G. H. Parker, professor of zoology in Harvard University, Cambridge, Mass. Dr. Parker investigated the reactions of the shore sponge, *Stylotella*. No physiological evidence of nervous tissue was found, though the sponge reacted to changes in the environment by opening and closing its oscula and pores, and by moving its body as a whole. These movements were produced by tissue resembling a primitive kind of smooth muscle. They were apparently caused by the direct stimulation of the contractile tissue. The conclusion was reached that in phylogeny muscular tissue had preceded nervous tissue in time of origin.

Dr. E. P. Lyon, professor of physiology, St. Louis University School of Medicine, St. Louis, Mo. Dr. Lyon worked on the following problems: (1) The catalase of echinoderm eggs before and after fertilization. An apparent large increase of catalase is found after fertilization. The results of this investigation were published in the *American Journal of Physiology* for December, 1909. (2) The comparative autolysis of eggs before and after fertilization. The chemical work on this problem has been continued since leaving Beaufort and the results are nearly ready for publication.

Dr. E. W. Gudger, professor of biology in the State Normal College, Greensboro, N. C. Dr. Gudger was chiefly occupied in continuing his investigations of several years' standing on oral gestation in the gaff topsail catfish, *Felichthys felis*, and in collecting material for the study of its embryology. He was successful in pushing back its life history by several days and lacks only the segmentation and invagination stages of having a complete series of eggs and embryos.

He also began a study of the viviparous top minnow, *Gambusia affinis*, and collected various unusual and interesting fishes the data concerning which have been embodied in a paper now in press.

Dr. Alvin S. Wheeler, associate professor at the University of North Carolina, Chapel Hill, N. C. The composition of the sea water at five points near the laboratory was accurately determined. The results agreed closely with each other but showed certain differences from deep-sea waters and shore waters in other parts of the world.

Dr. I. F. Lewis, professor of biology, Randolph-Macon College, Ashland, Va., completed his study of the flora of Shackleford and Bogue banks, and his report has been submitted to the commissioner of fisheries.

After a brief discussion of the geology, soils, physiography and climate of the region, the plant formations are considered. The vegetation is treated under the following heads: I., sand strand vegetation—(1) treeless (open), (2) trees and shrubs (closed); II., marsh vegetation—(1) salt marsh, (2) creek marsh, (3) dune marsh, (4) tidal flat.

Under these heads each plant association is described, and the characteristic species noted. Following this discussion of what may be termed the units of vegetation, a general account of the vegetation of the banks is given, in order to present as clear a picture as possible of the conditions obtaining on the banks at the present time.

The present plant covering was found to be in process of destruction by certain physiographic agencies. Measurements showing the rapidity of action of these agencies are given, and methods suggested for the conservation of the vegetation. In this connection the soil-building and sand-binding plants of the region are described and their value indicated for reclamation work.

The geographical distribution of the plants occurring on the banks is discussed, and comparisons instituted with other points on our South Atlantic coast and with the littoral flora of Alabama. The littoral floras of North and South Carolina and Alabama are found to be typically austro-riparian in char-

acter, though many of the plants common on the mainland are absent from the wind-swept sandy reefs.

The report closes with a classified list of the 268 species of ferns and flowering plants collected. Of these, 11 are new to the flora of North Carolina.

Dr. W. D. Hoyt, Bruce Fellow, Johns Hopkins University, Baltimore, Md., continued the study of the marine algæ, begun in previous summers. This region, unlike most of the southern coast, is found to have a fairly rich algal flora, one hundred and nineteen species being recorded up to the present time. The location of Beaufort, intermediate between the northern and southern regions, makes this flora of special interest, since many forms reach their northern limit here, while others have this for their southern boundary. The presence of a submerged coral reef off the coast gives a supply of subtropical forms on the beach.

The study that is being made includes the conditions of growth, the distribution of the algæ, and the factors controlling this distribution. Collections were made throughout the winter (1908–09) and kept for study, thus giving a view of the algæ throughout the entire year. The work was extended to the coast south of Beaufort, visits being made to nearly every accessible point between this place and Tybee, Ga. Notes were obtained which will furnish interesting comparisons of the distribution and conditions of growth with those of Beaufort. The final report will soon be submitted.

Mr. Raymond Binford, professor of biology in Guilford College, Guilford College, N. C., worked on the life history of the stone crab, *Menippe mercenaria.* A large number of crabs were kept under observation in tanks in the laboratory and in floats at the wharf. From these the spawning habits were observed and the development up to the third larval stage was worked out. The period from spawning to hatching covers eleven to thirteen days, from hatching to the third larval stage about four weeks. At this time they have not yet reached the megalops stage. The strength of the claw muscle was tested and the molting habits observed. Crabs were collected varying in size from 4.5 mm. to 182 mm. across the carapace. A study of the frequency of molting and the increase of size at each molt indicates that they reach the egg-laying size, 56 mm. across the carapace, within a year from the time of hatching. About a thousand of these stone crabs were caught in and about Beaufort Harbor during the summer. There is a ready sale for them at 65 cents per dozen.

Eggs from other species of crabs were hatched in the laboratory, viz., the mud crab, the oyster crab, a crab found in the *Atrina* (*Pinna*) shell, one taken from the *Chætopterus* tube and the blue crab, *Callinectes sapidus.* *Callinectes* was followed through six molts beginning with the megalops stage. It made those molts within a period of thirty-seven days and reached a size thirteen millimeters across the carapace. Some experiments in hatching and rearing the young were undertaken. It is proposed to continue work along this line during the coming summer.

Mr. B. H. Grave, Johns Hopkins University, Baltimore, Md., spent two months at the laboratory studying the anatomy of *Atrina* (*Pinna*) *rigida* Dillwyn. The greater part of the time was spent in injecting and dissecting the vascular system. Experiments were carried on to ascertain the rate and method of the growth of shell and an attempt was made to determine whether the calcium salts, used in shell growth, are taken directly from the sea water or from the blood of the mollusk. The results of this work will soon be ready for publication.

Mr. W. H. Kibler, of the department of science of the Durham High School, Durham, N. C., was engaged in a general study of the fauna of Beaufort and a study of the embryology of *Arbacia, Toxopneustes* and *Turritopsis.* In studying the fauna observations were made upon about forty common forms, and in addition a dozen or more species of fishes were collected and identified. The eggs of *Arbacia* and *Toxopneustes* were artificially fertilized. The development was normal and

reached the stage of the fully developed pluteus. Later stages of young echinoderms were obtained in tows. The eggs of *Turritopsis* developed through the planula stage. Eggs of *Chætopterus* and *Thalassema* were artificially fertilized.

Mr. George W. Corner, 3d, medical student at the Johns Hopkins University, Baltimore, Md., spent the months of July and August collecting and studying the invertebrates.

HENRY D. ALLER,
Director

SPECIAL ARTICLES

PRELIMINARY NOTE ON THE LIFE OF GLACIAL LAKE CHICAGO

EXCAVATIONS made for the new sanitary canal, which will extend from Willmette to the North Branch of the Chicago River at Bowmanville, have disclosed a series of beds filled with organic remains which reveal very fully the characteristic faunas of the several stages of glacial Lake Chicago. The cut at the Bowmanville end of the canal is a mile long; the depth is about twenty-five feet, fifteen of which are in boulder clay (glacial till) undisturbed by water action. The upper ten feet are composed of alternate layers of sand, clay, peaty material and shell beds. These strata quite fully portray the biologic history of the lake.

The area through which the canal is cut lies behind (west of) the Rose Hill bar and the strata exhibited in section were successively the bed or floor of Lake Chicago. These strata may be described as follows: Above the till there is a bed of sand from two to twelve inches in thickness. This doubtless represents the Glenwood stage and, as would be expected, no life is present. Above the sand is a bed ten to eighteen inches thick, composed of clay mixed with peaty matter, logs of wood and leaves of trees (oak and spruce). Molluscan shells of the genera *Planorbis, Physa, Lymnæa, Ancylus, Sphærium, Pisidium* and *Amnicola* abound. The presence of this extensive deposit, which can be traced the entire length of the canal, beneath deposits unquestionably of Calumet time, strongly supports, if indeed it does not prove, the early contention made by Dr. Andrews of a post-Glenwood low-water stage. The species of mollusks are mostly those found in swamps or along the edges of shallow bays or lakes.

Above the clay is a deposit of sand and gravel, two to nineteen inches in thickness, on the surface of which is one of the thickest beds of naiades the writer has ever seen. There are upwards of a dozen species, including *Unio gibbosus, U. crassidens, Quadrula undulata, Q. rubiginosa, Q. trigona, Q. verrucosa* and *Q. pustulosa.* With these are associated *Campeloma, Sphærium* and *Goniobasis.* The shells are species which frequent large streams of more or less rapidly flowing water, as the Illinois and Mississippi rivers, which fact, together with the unassorted character of the sand and gravel, shows that there was a rapid flow of water from the lake to the Desplaines outlet behind the Rose Hill bar. This deposit is believed to represent the Calumet stage. The presence of *Unio crassidens* is of great interest, as this species is not now found north of La Salle County in Illinois.

Above the Naiad deposits there are alternate beds of clay and sand, with occasional pockets of shells, the aggregate thickness being about thirty-two inches. The presence of peaty matter and wood afford evidence of a second low-water stage. In one of these deposits the humerus of a small bird was found as well as several fish spines.

Above this deposit there is a bed of molluscan shells forming a compact mass from one and one half to five inches in thickness. These are of swamp or bay species of the genera *Lymnæa, Planorbis, Physa, Valvata, Campeloma, Amnicola, Sphærium, Pisidium,* etc. Naiades are uniformly absent. This deposit was formed during the early portion of the Toleston stage, when the area behind the Rose Hill bar formed a reed-bordered bay. Above the shell bed is a deposit of clay seven to twelve inches in thickness, and above this, a typical peat deposit three and one half to eight inches in thickness. This deposit was formed in a small lake or pond, as it is of small extent. The region at this time was of

a swampy nature and contained numerous summer-dry ponds, similar to those found in the Skokie Marsh area. Above the peat deposit the surface soil is about two feet in thickness.

It has been stated by Goldthwait[1] and others[2] that there are no certain traces of life in the lake during the Glenwood and Calumet stages. It may be true that life was not abundant during the early part of the Glenwood stage, but the evidence afforded by the deposits discussed above conclusively prove that life was abundant during late Glenwood time, very abundant during Calumet time and has continued to be so to the present time, for the Chicago River as well as the smaller streams and summer-dry ponds in this area now teem with molluscan life.

The presence of a species of spruce (*Picea evanstoni*) as well as an oak (*Quercus marceyana*) has led to the belief that a climate similar to that of Alaska prevailed during the early part of the period (Glenwood) during which Lake Chicago was forming. The presence of *Unio crassidens*, essentially a southern species, in the Calumet deposit, indicates, apparently, a period of higher temperature during this later time. That this species had a much more northern distribution during early postglacial time is evidenced by its presence in a deposit at Green Bay, Wisconsin.[3]

The northern records of *crassidens* may be tabulated as follows:

	South of Green Bay Record
Wisconsin, between Prairie du Chien and De Soto[4]	80 miles.
Minnesota, not recorded.	
Iowa, Lansing[5]	80 miles.
Michigan, not recorded.	
Illinois, Utica, La Salle Co.[6]	220 miles.
Ohio, Scioto River[7]	260 miles.
Indiana, Tippecanoe River[8]	230 miles.

The most northern extension of this species at the present time is in the Mississippi River, where it has been collected as far north as Prairie du Chien and probably lives as far north as De Soto. In Illinois and Indiana the northern range is 150 miles farther south. *Crassidens* is essentially a southern species, abundant in the southeastern part of the United States where its center of distribution is in the neighborhood of Tennessee. Its northern extension indicates a more genial climate than that which now prevails in the northern states. The route of migration to Green Bay is difficult to predict with certainty. The Lake Chicago fauna undoubtedly migrated up the Mississippi-Illinois-Desplaines Rivers. It is interesting to note that the species associated with *crassidens* are typical of a temperate climate and are, for the most part, living in this region at the present time.

It is very important that records of *crassidens*, both fossil and recent, be secured in Wisconsin, Michigan and northern Illinois, Indiana and Ohio. It is possible that the bed of glacial Lake Maumee would reveal strata similar to those observed in Lake Chicago, and as *crassidens* is found in the Wabash River, it may have migrated into Lake Maumee.

Studies on this subject are not now far enough advanced to warrant generalizations. A report illustrated by photographs and stratigraphical sections, and with tables of the species, together with their geographic distribution, past and present, is in preparation. The writer would solicit authentic northern records of *crassidens* for the purpose of establishing the present geographic distribution of this species. It would also be of great value if *crassidens* could be discovered in postglacial deposits in Wisconsin and Michigan, as well as in northern Ohio and Indiana. Full credit

[1] Bull. Ill. Geol. Surv., No. 7, p. 63, 1908.

[2] Alden, "Geol. Atlas of U. S.," Chicago Folio, No. 81, p. 11, 1902.

[3] Wagner, *Nautilus*, XVIII., pp. 97–100, 1905. This specimen has been personally examined.

[4] Chadwick, *Bull. Wis. Nat. Hist. Soc.*, IV., p. 95, 1906.

[5] Museum record.

[6] Baker, Bull. Ill. State Lab. N. H., VII., p. 77, 1906.

[7] Sterki, *Proc. Ohio Acad. Sci.*, IV., p. 392, 1907.

[8] Daniels, 27th An. Rep. Dept. Geol. Ind., p. 659, 1902.

will be given in the final report for any assistance of this character, should such be submitted to the writer.

FRANK C. BAKER,
Curator
CHICAGO ACADEMY OF SCIENCES

COLLETOTRICHUM FALCATUM IN THE UNITED STATES

DURING the past two years, while studying the diseases of sugar-cane, careful search has been made for those which are troublesome in other countries but which are not known to occur in the United States. During the past year one of these has been found in Louisiana, and from material received from another state, this may be more widely distributed than was at first thought. This disease is one which is caused by the fungus *Colletotrichum falcatum* Went. This has been reported previously in nearly every sugar raising country in the world, in some places doing a large amount of damage. According to Butler[1] this fungus sometimes causes an immense loss in Bengal. Several common names have been applied to this disease, but the one in most common use in English-speaking countries is the red-rot disease.

The first specimen of this disease was found on a plantation in Orleans parish, Louisiana, in September, 1909. One cane was found which had a lesion about two centimeters in diameter which was covered with the fruiting pustules of this fungus. No other diseased stalk was found in the field. I was not willing to make a positive identification at the time because the causative fungus is very similar to *Colletotrichum lineola* Cda., which occurs very abundantly on Johnson Grass in this region, and it was barely possible that this latter fungus had gained an entrance into a wound in the cane. But since other material has been received there seems little doubt but what this was the true red-rot fungus.

[1] Butler, E. J., "Fungus Diseases of the Sugar-cane in Bengal," *Memoirs Dept. Agr. in India*, Botanical Series, Vol. I., No. 3, Pusa, 1906.

During the fall and winter of 1909 and 1910, a planter in Georgia, Mr. W. B. Roddenbery, of Cairo, who has had considerable trouble with a disease in his cane wrote to the sugar station at New Orleans and also sent specimens. This material was resent to me and I have since made a careful study of the trouble. There is no doubt but that it is the red-rot disease in a very serious form. He estimates that one third of the cane which he wished to use for planting was diseased.

As this disease is generally confined to the inside of the stalk, an examination of the external part usually shows but very little of the trouble. Unless the cane is severely affected the disease would ordinarily be overlooked, unless it was examined very carefully or unless the stalks were split. However, when the cane is severely affected, the rind covering the nodes, and even strips on the internodes, become dark brown in color, and the eyes are usually dead. If the stalks are split, the nodal region will be found to be badly decayed, with strips of red and brown extending out into the internodes. One of the distinguishing characters of the disease is the presence of light-colored spots surrounded by red or brown tissue. These were fairly abundant in the Georgia material. These have not been satisfactorily explained but it appears as if they are points where the fungus is present, it generally not being present in the red and brown surrounding tissue.

The fungus was found fruiting in some large internodal lesions on some soft top joints of one stalk, on the brownish colored nodes of two stalks, and also fruited on a split stalk that was kept moist. In the latter case, the fruiting postules developed directly from the diseased center of the node. A microscopical examination of the diseased tissue of the cane showed the presence of the typical mycelium and many of the so-called "appressoria" in the host cells.

This fungus is very similar, if not identical from a morphological standpoint, to *Colletotrichum lineola* Cda., mentioned above. The latter fungus has also been studied and inocu-

lation experiments have been tried on sugar cane but without success. The fungus would grow, and also fruit to some extent, at the point of inoculation, but would not spread into the healthy tissue.

C. W. Edgerton

Louisiana Agricultural Experiment Station

SOCIETIES AND ACADEMIES

THE GEOLOGICAL SOCIETY OF WASHINGTON

At the 229th meeting of the society, held at the George Washington University on Wednesday evening, March 9, 1910, informal communications were presented as follows:

Mr. Chas. A. Davis exhibited a map showing the distribution of workable peat deposits in the United States and their relation to the areas of glaciation and heavy precipitation.

Mr. E. G. Woodruff presented a diagram constructed from measurements made along an outcrop of coal beds in central Wyoming, showing their pronounced lenticular character.

Mr. J. T. Pardee exhibited photographs and a sketch map of the region covered by the former glacial Lake Missoula, which once occupied some 4,500 square miles in the drainage basin of the Clark Fork in northwestern Montana and was dammed by a south flowing ice tongue of the Cordilleran ice cap near Lake Pend d'Oreille.

Regular Program

A Microscopical Study of some Sulphide Ores: F. B. Laney.

A Proposed Classification of Petroleum and Natural Gas Fields based on Structure: Frederick G. Clapp.

The classification is a tentative one which was evolved at least in part in order to illustrate to oil operators the differences in geological conditions in different fields. The main divisions of the classification are as follows: (I.) Anticlinal and synclinal structures; (*a*) strong anticlines standing alone, (*b*) well-defined anticlines and synclines alternating, (*c*) monoclinal slopes with change in dip, (*d*) terrace structures, (*e*) broad geanticlinal folds. (II.) Domes, or quaquaversal structures (Salines). (III.) Sealed faults. (IV.) Oil and gas sealed in by asphaltic deposits. (V.) Contact of sedimentary and crystalline rocks. (VI.) Joint stacks.

As examples of subclass I. (*a*), the fields on the Eureka-Volcano-Burning Springs anticline of West Virginia and certain California fields are given. In subclass I. (*b*) are placed most of the fields related to anticlines and synclines in the Appalachian province, the Caddo field of Louisiana, the Coalinga and Los Angeles fields of California and the Burma and other well-known fields in other countries. The majority of the oil and gas pools of southeastern Ohio belong in division I. (*c*), or in I. (*d*) which is an exaggerated form of I. (*c*). The best example known of subclass I. (*e*) is stated to be the extensive field on the Cincinnati anticline in Ohio and Indiana. Class II. includes the fields of the gulf coastal plain. Class III. is exemplified by certain pools in the Lompoc field and perhaps other fields of southern California. Class IV. is somewhat hypothetical, so far as oil and gas accumulations of economic value are concerned, but it may be exemplified by the pitch lake of Trinidad. Class V. is known to exist in the Province of Quebec and to some extent in northern New York state, where natural gas is found in the arkose zone of the Potsdam sandstone resting on prominent knobs in the underlying crystalline rocks. Class VI. was added after the discussion in accordance with a suggestion by Mr. M. R. Campbell. An example of it is a part, at least, of the Florence oil field in Colorado. In illustrating the proposed classification, several notable deficiencies in past assumptions of geologists and oil operators were mentioned, and the lessons to be drawn from them in the light of recent developments were emphasized.

Some Notes on the Mammoth Cave, Kentucky: James H. Gardner.

The Mammoth Cave is essentially a product of solution in the St. Louis Limestone, which in this section of Kentucky is about 500 feet thick. Meteoric waters charged with carbonic acid gas began permeation of joint planes in the limestone as soon as Green River had cut its channel through the Kaskaskia sandstone into the St. Louis. In the opinion of the speaker these joints were produced by pressure exerted from the Cincinnati Arch either by movements of uplift or subsequent settling. The drainage of this section of Kentucky is chiefly underground where the St. Louis is the surface rock and the formation is one abounding in subterranean caverns.

The present entrance to the cave, which is in the hills bordering the east banks of Green River, is doubtless the original exit of Echo River, though this stream has found lower outlets from time to time and is now about 195 feet below this level. Writers on the cave have considered this

entrance in the light of its being an opening produced by falling in of the roof. It has this appearance due to the accumulation of talus in front of the mouth.

Brief references were made to the fauna of the cave in its relation to the effects of environment in the origin of species. Physical and geological phenomena were discussed including the movements of air currents, origin of calcium nitrate, deposits of calcium carbonate and gypsum rosettes.

FRANCOIS E. MATTHES,
Secretary

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE

THE thirty-eighth meeting has held at the Cornell University Medical College on Wednesday, April 20, 1910, at 8:15 P.M., with President Morgan in the chair. An executive meeting was held.

New members elected: Anna W. Williams, Katharine R. Collins, A. J. Goldfarb and Herman M. Adler.

Members present: Atkinson, Auer, Beebe, R. I. Cole, Cooke, Crile, Dochez, Ewing, Foster, Gies, Jackson, Jacobs, Joseph, Kast, Lamar, Lee, Levin, Leo Loeb, Lusk, MacCallum, McClendon, Meltzer, A. Meyer, Morgan, Murlin, Noguchi, Opie, Pearce, Rous, Shaffer, Shaklee, Torrey, Van Slyke, Weil, Wolf.

Scientific Program

"On the Behavior of Autodermic and Isodermic Skin Grafts in Cancer," G. W. Crile.

"Further Observations on the Hemolysis in Cancer," G. W. Crile.

"On the Neurocytologic Changes in Shock, Infections, Grave's Disease and with Certain Drugs," G. W. Crile.

"On Yeast Nucleic Acid," P. A. Levene and W. A. Jacobs.

"The Contact Irritability of the Uterine Mucosa," Leo Loeb.

"Adsorption of Venom of Heloderma," Leo Loeb and M. S. Fleisher.

"A Note on Parabiosis between Mice and Rats," R. A. Lambert.

"A Demonstration of the Inhibitory Effect of Magnesium upon Normal and Artificial Peristalsis of the Stomach and the Duodenum," D. R. Joseph and S. J. Meltzer.

"Recovery from Fatal Doses of Strychnine by the Aid of Curarin and Artificial Respiration (Insufflation Method)," A. O. Shaklee and S. J. Meltzer.

"Intracellular Proteolytic Enzymes of the Liver," A. R. Dochez.

"Enzymes and Antienzymes of the Blood Serum with Certain Degenerative Changes in the Liver," Eugene L. Opie and B. I. Barker.

"A Preliminary Note on Experimental Lobar Pneumonia with a Demonstration of Specimens," R. V. Lamar and S. J. Meltzer.

"Experiments bearing on the Nature of the Karyokinetic Figure," T. H. Morgan.

"The Effect of Vagus Section upon Serum Anaphylaxis in Guinea-pigs," J. Auer.

"Notes on the Vaso Reaction in Dogs produced by Injections of Extracts of the Tubercle Bacillus," J. P. Atkinson and Charles B. Fitzpatric.

"Immunity to the Growth of Cancer induced in Rats by Treatment with Mouse Tissue," Isaac Levin.

"The Early Stages of the Spontaneous Arterial Lesions in the Rabbit," Isaac Levin and John H. Larkin.

(A) "Artificial Cyclopia in the Smelt," (B) "Cataphoresis of Proteids in the Living Cell," J. F. McClendon.

"Nitrogen and Sulphur Metabolism in Morbus Ceruleus," N. B. Foster.

The following communications were read by title:

"Parenteral Protein Assimilation," P. A. Levene and G. M. Meyer.

"A Method of Isolating the Cerebro-medullary Circulation," Arthur B. Eisenbrey.

"A Reversion of the Starch-dextrin Reaction," Edward T. Reichert.

(A) "The Rôle of Alkali in the Development of the Egg of the Sea-urchin," (B) "How can the Process Underlying Membrane Formation cause the Development of the Egg?" Jacques Loeb.

"An Investigation of the Place of Formation of Immune Bodies by the Method of Organ Transplantation," A. B. Luckhardt.

"The Concentration of Ammonia in the Blood of Dogs and Cats Necessary to produce Ammonia Tetany," Clara Jacobson.

"The Non-production of Sugar from Tyrosin and Glucosamin in Phlorhizin Glycosuria," A. I. Ringer and Graham Lusk.

"The Daily Curve of Nitrogen Elimination in the Pregnant, as compared with the Non-pregnant Dog," J. R. Murlin.

"Rate of Contraction of Muscle under the Influence of a Voluntary Stimulus," H. B. Williams.

"Filtration through Collodion Sacs," Edna Steinhardt.

"The Activation of Pancreatic Extract," A. R. Dochez.

EUGENE L. OPIE,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NEW YORK SECTION

THE seventh regular meeting of the session of 1909–10 was held at the Chemists' Club on Friday, April 8.

Dr. F. D. Dodge read a paper entitled "Notes of the Determination of Essential Oils."

The remainder of the program consisted of a symposium on leather, arranged by Dr. Allen Rogers, which included the following papers:

"General Outline of the Industry," Allen Rogers.

"The Process of Bating," Alan A. Claflin.

"Vegetable Tanning Materials," John H. Yocum.

"Recent Advances in Chrome Tannage," Otto P. Amend.

"The Coloring of Leather," F. E. Atteaux.

"Oils used in the Leather Industry," Edgar A. Prosser.

C. M. JOYCE,
Secretary

THE UTAH ACADEMY OF SCIENCES

THE third annual meeting of the academy was held at Salt Lake City, on Friday and Saturday, April 1–2, 1910.

The sessions opened at 8 P.M. Friday evening and 2 P.M. Saturday afternoon. President W. C. Ebaugh occupied the chair.

At the annual election held on Saturday afternoon, the following officers and members of the council were chosen:

President—Dr. E. D. Ball, Utah Experiment Station, Logan.

First Vice-president—C. C. Spooner, Salt Lake High School.

Second Vice-president—Dr. S. H. Goodwin, Proctor Academy, Provo.

Secretary—A. O. Garrett, Salt Lake High School.

Treasurer—John B. Forrester, Salt Lake City.

Councilors-at-large—Professor Marcus E. Jones, Dr. C. T. Vorhies, A. F. Greaves-Walker.

The following papers were read at the annual meeting:

"A General Survey of the Jurassic of Southeastern Utah," John B. Forrester, Salt Lake City.

"Mendelism," Dr. E. D. Ball, Utah Experiment Station, Logan.

President's address, Dr. W. C. Ebaugh, University of Utah, Salt Lake.

"Preliminary Report on the Animals of Great Salt Lake," Dr. C. T. Vorhies, University of Utah, Salt Lake City.

"Recent Analyses of Water from Great Salt Lake," Wallace Macfarlane, Salt Lake City.

"Preliminary Report of the Plants of Great Salt Lake," L. L. Daines, University of Utah, Salt Lake City.

"Recent Progress in Economic Entomology," Professor E. G. Titus, Utah Agricultural College, Logan.

"Efflorescence or Scum on Brick Work," A. F. Greaves-Walker, Salt Lake City.

"A Reported Occurrence of Native Iron in Utah," Dr. W. C. Ebaugh, University of Utah, Salt Lake City.

"The Composition of Solids Precipitated from the Atmosphere during 'Salt Storms,'" Dr. W. C. Ebaugh.

A. O. GARRETT,
Secretary

ST. LOUIS SECTION, AMERICAN CHEMICAL SOCIETY
ST. LOUIS CHEMICAL SOCIETY

THE following papers have been presented before these two affiliated chemical societies, at the meetings held in January, February, March and April, 1910.

"Timber Preservation," Messrs. A. L. Kammerer and E. B. Fulks.

"The Action of Magnesium upon the Vapors of Organic Compounds," Professor E. H. Keiser.

"The Extraction of Glycerine from Soap Lye," Mr. Clarence B. Cluff.

"Chemistry in America and Germany," "Electrolytic Preparation of Hydrazine," Mr. R. F. Weber.

"Terpeneless Extract of Lemon, and Methods of Analysis thereof," Dr. S. H. Baer.

"A Rapid Method of Estimating Iron in Iron Ores," Dr. LeRoy McMaster.

"Ozone in Water Treatment," Mr. W. F. Montfort.

The two societies also have visited the plants of the Laclede Gas Light Company and of the N. K. Fairbanks Co., the plant of the latter company, in St. Louis, being engaged in the manufacture of laundry soap and washing powder.

R. NORRIS SHREVE,
Sec. St. Louis Sec. Amer. Chem. Soc.
GEO. LANG, JR.,
Rec. Sec. St. Louis Chem. Soc.

SCIENCE

FRIDAY, MAY 13, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE WORK OF THE HIGHER EDUCATION ASSOCIATION[1]

THE Higher Education Association was formed in May, 1909, under a charter which will be referred to later. It was not formed to increase college endowment or teaching facilities, but rather to bring about, if possible, changes in the methods and results of the various departments of the college, to organize and conduct a campaign to obtain better educational results from the splendid equipment of men, material and money with which the American people have endowed the American colleges.

To understand the association's purposes it is necessary to know its point of view. In what I shall say at this time I shall speak almost exclusively of the college as an institution and not of the teaching force as individuals; of the official college and its lack of methods, or its false and archaic methods; of its catalogue or diploma values as distinguished from its educational values; of the cast-iron armor of formalism with which the institution as such benumbs or kills the life-giving educational efforts of the teaching force. However harshly I may speak of the institutional methods and ideals, I have the greatest possible sympathy with the men and women who are fettered by these methods, and who are often condemned to make bricks without straw.

To make myself clear I must point out as briefly as possible how and why the

[1] Read before Section L, Boston, December, 1909.

American colleges have changed their official emphasis from training for character and citizenship to training for class-room work and marks, and examinations to test class-room acquirements and for grade promotion.

Until about a century ago every college was conducted as a boarding-school home, with moral, religious and mental growth as a matter of far more serious concern that class-room work or diploma values, and without any catalogues.

A six months' probationary period for freshmen prevailed at Yale till 1848, but officially applied to *moral conduct* and not to *class-room marking*. The Yale laws provided that,

> The senior Tutor shall keep a matriculation book, in which shall be registered the names of all students, who by their regular behavior, and attention to collegiate duties, for six months at least after their admission, shall exhibit evidence satisfactory to the Faculty of their unblemished moral character. And if any candidate shall fail of exhibiting such evidence, within a reasonable time, he shall be allowed to attend on the exercises of the College no longer. Each candidate shall be particularly required to exhibit proof that he is not guilty of using profane language. All those who are Students on probation, as well as the regular members who have been matriculated, shall be subject to the laws, penalties and discipline of the College. No candidate's name shall be registered, until he shall have subscribed the following engagement:
>
> I, A. B., on condition of being admitted as a Student of Yale-College, promise, on my Faith and Honor, to observe all the Laws and Regulations of this College; particularly, that I will faithfully avoid using profane language, gaming, and all indecent, disorderly behavior, and disrespectful conduct to the Faculty of the same: as witness my hand,
>
> A. B.

A study of Yale's printed laws from 1765 to 1906 enables us to trace certain fundamental changes in the college and its ideals. Seventy per cent. of the laws of 1774 related to the regulation of the student's personal and college life as distinguished from class-room work or the functions of the college or its departments. Two chapters were entitled, respectively, "Of a pious and religious life" and "Of a regular moral behavior." The entire examination is treated in fourteen lines, as follows:

> No Person may expect to be admitted into this College, unless, upon an Examination by the President and Tutors, he shall be found able extempore to read accurately, construe and parse Tully, Virgil, and the Greek Testament, and shall be able to write true Latin in Prose, and hath learnt the Rules of Prosody and vulgar Arithmetic; and shall bring suitable Testimony of a blameless Life and Conversation.
>
> About the twentieth of July (on a Day appointed by the President) the Senior-Sophisters shall appear in the Chapel, to be examined by the President, Fellows, Tutors, or any other Gentlemen of liberal Education, touching their Knowledge and Proficiency in the learned Languages, the liberal Arts and Sciences, and other Qualifications requisite for receiving a Bachelor's Degree.

There was nothing about marks or the marking system. This relative unimportance of class-room work, examinations and the marking system gradually changed until in the printed laws of 1906 we find the proportion more than reversed, and only ten lines, or 95 words, devoted to conduct as such, while over 13 pages, or about 450 lines, relate to the marking system, class-room work and grade examinations. The laws of 1774 were not supplemented by any catalogue. The present-day laws are a mere supplement to an 800-page catalogue. I call attention to this entire change of *official* emphasis merely to direct your thoughts to the genesis and results of a right-about movement universal in the colleges which, if studied earnestly and impartially, may show us the source of some of our present troubles and the way out.

The life of the bread-winning citizen is

lived upon three distinct planes: the statutory or governmental plane, wherein the written law defines, commands or forbids certain rights, duties and acts; the contract or community plane, wherein contracts, more or less formal, govern his relations with his fellows in the community and in his profession or business; and lastly, the home plane, wherein the parent or other head teaches and enforces his precepts and his commands under quite a different law than that of the governmental or community planes.

Turning to the governmental plane, we find that the statute recognizes and punishes legal crimes and misdemeanors but not moral or social vices. It takes no cognizance of even the blackest lie unless it assumes the form of legal perjury or of criminal slander or libel. It does not reach private betting or gambling, or many other forms of social vices, any more than it does selfishness, sloth, inattention to business, breach of contracts, overreaching, Sabbath breaking and thousands of other things which we speak of as moral or social shortcomings. These belong to the community or home planes.

The statute can not make a man honest or moral or religious any more than it can make him fat or lean, or say what he shall eat or drink, or how he shall train his children or treat his wife. The statute, likė all forms of governmental control, is artificial and inherently weak, and covers only the relation of the individual to the government or to those who have joined with him in giving up certain natural rights that they may have the protection of a common government. From its very nature, the statutory plane is the weakest and lowest in our lives, unknown in strictly patriarchal times and a necessity only as communities form and grow and intermingle. The statute has little to do with moral character. If the veriest saint breaks the statute he is guilty of a crime or misdeameanor, and if the worst villain keeps within the written law, or is not proved guilty, he is accounted innocent. By careful observance of the written law a man does not become a model citizen. On the contrary, he may be dishonest, dishonorable or shiftless in his professional or business career, or be profligate in his home, or be selfish, cross-grained and unlovely in every way. In fact, it is the latter kind of men who are most likely to observe the letter of the statute.

When there was no adequate preparatory school system below the college, it was the last room of the boy's education. Now with a complete public school system below it, the college has become the first room of the young man's training for citizenship and should be so regarded. As befits the threshold of its students' citizenship, the college to-day has its clearly defined statutory or governmental, its community and its home planes; but it takes official cognizance only of the statutory plane in arriving at diploma values, and, officially and as an institution, neglects and apparently despises the community and home planes and the important educational effects for which they stand in the life of the future citizen. As we shall see, the American colleges long since and needlessly abandoned any close organic connection with the home and community planes of the college life and concentrated their official notice upon class-room work.

The college might have continued to use officially a clean and stimulating home life to aid in class-room work and in the development of citizens who should have high ideals of their duties in the college home and afterwards as husbands and parents in their own homes. But the institution allowed its pendulum to swing from an

over-emphasis of the college home to a substantial abdication of all home functions, and to an even greater over-emphasis of class-room work and grade examinations. First the state universities, which now contain more than one half of all students, decided to build no dormitories. Then new private colleges, like Cornell, were founded with no provisions for dormitories or any other institutional connection with the home plane. Finally, the older colleges, like Amherst, which had been strongest in their early religious and home life, gave up building new dormitories and even needlessly tore down some old ones. The reason for this is evident. The new college, the new spirit of learning, especially the new-born elective system, required constantly more money for new buildings and a larger faculty. Hence it was argued that the American college might well abandon all exercise of its home functions, and concentrate upon the curriculum. The unwisdom of thus abandoning instead of remodeling the home plane has long been apparent.

The words of the Psalmist have been changed in the college scriptures to read, "When my alma mater forsakes me, then the students and alumni will take me up." After the colleges had abandoned the home, but only thereafter, the students revamped the college secret society, and called it a fraternity, and with the aid of the alumni set it to building college homes. To-day these homes house more students than the college barracks, but together the homes and the barracks do not shelter one quarter of all the students. But the college as such has lost all organic control of the home plane and its formative and educational powers; and in determining diploma values, relies more and more upon the artificial and educationally ineffective college statute and ordinance and marking system and examinations for promotion only, and officially not at all upon those moral qualities which are learned only in the home. If a well-fitted student fails or falls behind in his course, it is probably because of shortcomings upon the home plane, which the college meets by a little greater activity upon the statutory plane, by harsher marking and stricter examinations, rather than by a reformation upon the home plane where the real trouble exists.

Turning briefly to the college community life, we find the same kind of error upon the part of this nourishing mother. About forty years ago, and after the college had abandoned its home functions, there began a steady growth upon the college community plane, which until then had not existed. By the college community life I mean that part of the general student life, outside of the curriculum, which affects the student body as a whole; the twenty-seven or more well-defined college activities in which there are intercollegiate records, or in which, as in dramatics or the musical clubs or college journalism, there are presumed to be gathered the best talent which the college holds. The educational value of the college community plane is very great, and with many individuals even greater than that of the class-room. Emerson said in his essay on culture—please notice that it was in his essay on culture—"You send your child to the schoolmaster, but 'tis the school-boys who educate him"; and he continues a little later, "One of the benefits of a college education is to show the boy its little avail." A large part of the college education and training is gotten on the community plane. It teaches a man how to handle himself and his fellow-man and how to apply what he knows. This is the only plane where there are well-understood and universal intercollegiate records

and standards; and where anything but the best work is rebuked for alma mater's sake and in her name by a man's friends. It has no official marking system and no examinations, but gives judgment upon the spot by one's peers, who demand that each college champion shall put forth his utmost powers. Often this is the only plane in which an individual throughout four years has the very best teaching, and the very best coaching, and the very best practise which can be afforded, along a single line which is not mentioned in the college catalogue, but in which the college unofficially makes him a past master and expert.

Yet the college as such, from the first, could see no diploma values and hence no official values whatsoever upon the community plane, apparently because it was not class-room work. Directly and indirectly the colleges have gained millions of dollars and thousands of students because of the successful conduct by graduates and undergraduates of the various college activities, but officially, in their diplomas and their catalogues, the colleges do not admit the existence of these activities. A successful hero of the football field may attract to the college more new students than any three professors, but the time and strength thus spent for alma mater do not help him under the marking system or upon examinations. A strong editor of a college periodical or the leader in the cast of a Shakespearean play may do wonders morally or educationally for the college, but usually he gets no official or diploma credit—even in his English courses. The college organization meets any evils in the community plane, not upon that plane, not by a philosophical method, but by a greater emphasis upon the marking system and promotion examinations which belong to the statutory plane. Here again the college activities can say, "If my alma mater forsakes me, then the students and alumni will take me up."

We see, therefore, that when a new order arose on the college community and home planes, the institution did not put itself at the head of this new educational movement, but officially ignored its existence and enacted new standards of marks and promotion examinations and courses to meet evils which lay upon another plane. College evils and vices are chiefly upon the home and community planes, and can be effectually solved only by remedies acting within these planes—by public sentiment within the student body and among the alumni raising the ideals of the community life, and by the leaders in and the owners of the home acting upon the individual members of each home.

The changes which can be wrought in college upon the individual undergraduate are either physical, mental or moral, which latter term includes religious. These changes may be wrought—largely outside of the statutory plane—by the influence and personal character or teaching of any one of scores of instructors; by the college community life in any one of the twenty-seven or more college activities; by the general tone and stimulus of the student life; or by the social, moral or religious uplift or downpull of scores of college homes, each differing as do ordinary homes and each varying widely from year to year. Thus each little college cosmos presents an almost infinite number of combinations working upon and through the three planes of each student's life, which may well account for the totally different results of the college course in educational but not necessarily diploma values upon the individual. Yet the college as an institution puts all its official values upon class-room work and promotion examinations and an

inadequate and misleading marking system, and *officially* stops there.

Furthermore, this over-emphasis of its statutory plane is as harmful to the instructor as to the student. The freshman or his parent takes up an 800-page catalogue and finds therein the names of hundreds of instructors and courses which all look alike to him; for any course under any instructor stands officially for one point towards a 60 per cent. diploma. Officially the college does not recognize, nor in any way provide the means for recognizing, unusual power or successful work by any instructor. The college is like a great library without a catalogue. There is no official guide to the personalities and powers of the various instructors, and no means of determining these or their educational values upon individuals. There is merely student tradition that Professor X is great, Professor Y dull as blazes and Professor Z an easy mark. Officially and in its catalogue and diploma, or in any other way in which the public can judge, the college is absolutely institutional and does not regard the personality of student or instructor.

There is in business what is known as the standardizing of efficiency, which means the ascertaining and fixing of a constantly improving high standard of efficiency and the bringing up of all parts of the business thereto. It is thus a progressive movement. But it is administrative in its nature. This administrative nature does not vary, although its applications may be as wide as various kinds of businesses and industries. The men who specialize in this work often style themselves industrial engineers.

It is at this point that the Higher Education Association believes that it can assist the colleges by bringing in the students and alumni. It believes that the colleges need standardizing of efficiency and that this must come in large part through radical changes in the college administration. The present so-called administrative system is about as inadequate as it could well be, as shown by the pass to which, according to recent inaugurals, it has brought so-called college education. The general lines along which the Higher Education Association conceives that there should and can be standardizing of college efficiency, and in which it can help the individual student and instructor, and put more official value on personal worth and growth and less on marks and diploma values, is indicated by the following extracts from its charter:

The purposes for which said corporation is to be formed are as follows:

(*a*) To improve higher education throughout the United States, and in particular the internal and external conditions of the American college, by furnishing an agency and funds whereby a careful study can be made and improvements can be brought about in the institutions of higher learning, in the following ways, among others:

(1) In the financial department: a fuller and clearer treasurer's annual account; an improved and more complete system of bookkeeping; and through the development of an internal cost accounting system—in addition to the present method of merely accounting for the cash proceeds of trust and other funds—a more economical and intelligent administering of the resources, funds and activities of the colleges.

(2) In the department of instruction: the improvement of the pedagogical training of those proposing to teach in colleges; the conservation of the health and other interests of the instructional forces; the increase of their compensation; the provision of pensions; the safe-guarding and fostering of the interests of tutors, preceptors, assistants and other grades of junior or associate instructors; and the improvement of the administrative and other conditions affecting the teaching forces, collectively or individually.

(3) In the department of the student life: the betterment of the college community life and of the college home life, whether in the fraternity home, the college dormitory or the local boarding house; the restoration, so far as possible, of the individual training of the students, mentally,

morally and physically, during their college course and for their widest future usefulness as educated citizens.

(4) In the administrative department: the systematic study and wide adoption of better and more advanced college administrative methods, to secure the most efficient use of the college capital in character building and scholarliness; the devising and putting into force of new units of internal valuation of student and instructional work; the reduction of college waste and the college waste-heap in the student, instructional and other departments; the study of the college plant and field; the oversight and assistance of graduates; the bringing about, so far as is wise and desirable, of standardization and uniformity in college methods and standards; the making possible of the interchange of students and instructors; the relieving of the instructors from administrative details, and the putting of these under charge of administrative experts, whose duty it shall be to produce in every possible way conditions conducive to more efficient work of the instructional forces and to scholarliness.

(5) In the department of citizenship: the study of the civics and economics of the college itself, and of its various planes and departments, and of the relations of the student-citizens to the college state, the college community and the college home—all with reference to their future duties, as citizens, to their commonwealth, their community, business or profession, and their homes; the founding of chairs for the study of citizenship; the reorganization and fulfillment of the duties and responsibilities which the colleges themselves owe to the state as the capstones of a system of compulsory public-school instruction which has educated, at the public expense, most of the students who enter the colleges; and the restoration of the clear conceptions which the earlier institutions had of their direct and high obligations to the state as its public servants, to which had been intrusted public and private funds and powers.

(6) And generally to furnish means to determine and fix the true present position of the college in our educational system; to minimize the danger of injury to the colleges because of the push of the preparatory schools from below, and of the drain of the professional and graduate schools from above; and to inaugurate and foster an active forward movement in the development of the colleges and their curricula.

(*b*) To print and publish a magazine or magazines, and other periodicals, newspapers, pamphlets or books, and to do a general publishing business.

(*c*) To organize and carry on a bureau or department for the employment of professors, teachers and others connected with college instruction or administration.

(*d*) To investigate, through experts or otherwise, the exact conditions prevailing in the colleges, and to formulate plans to improve such conditions; to organize, develop and maintain, within or without the state of New York, voluntary and unincorporated associations and assemblages of college alumni or others interested in the affairs of the colleges or their students, whose direct object shall be to advance the cause of higher education, and to improve the administrative, business and financial situation in the colleges, in order to insure that the revision of the place, polity and ideals of the American college and the reorganization of its administration shall be in the hands of its friends and well-wishers; to raise and disburse the funds and money necessary or desirable to effectuate any of the purposes or objects of the company or the advancement of education within the United States.

(*e*) To do all and everything necessary, suitable or proper for the accomplishment of any of the purposes, or the attainment of any one or more of the objects herein enumerated, or which shall at any time appear expedient for the benefit of the company, to the same extent as natural persons might or could do, and in any part of the world, as principals, agents, contractors, trustees or otherwise.

But any progress along such extensive and radical lines must fail if we are confined to the use of the present false and limited standards of measuring internal values within the college. An A, B, C, D marking system and examinations for grade promotion furnish no real units for valuing the educational effect upon the individual of the moral, religious, physical and intellectual influences of the college home plane; or of the twenty-seven activities and the general atmosphere of the college community plane; or even of the real or relative mental, moral or physical value to any particular future citizen and the commonwealth which he should serve, of scores of

courses which have a very distinct diploma value in the catalogue and upon the statutory plane of the college. We can never expect real standardizing of efficiency until some body of men skilled in such matters and experts in college affairs devise new units of internal valuation applicable in the most intricate affairs of the different planes of the college; or until these are all made to work together for good by an adequate administrative department. And as a corollary to this, it follows that if the present college administrative system, so called, has utterly failed in handling the comparatively simple problems of the statutory plane, much more will it be unable to handle satisfactorily the further complications which must arise when the college takes official cognizance of the home and community life.

To the educator and instructor this seems chimerical and impossible of accomplishment. On the other hand, to the business man it seems impossible that our institutions of higher learning should expect to get adequate educational results, mental, moral, religious and physical, out of their $600,000,000 of capital, and $75,000,000 of annual income, working through 30,000 instructors upon 300,000 individual students, when there is no concerted study looking toward a standardizing of efficiency, and no units by which to value their work except the A, B, C, D marking system and the examinations for promotion, which at best can apply only upon one plane of the college economy.

The Higher Education Association believes that in a fragmentary and disconnected way the material for the standardizing of the efficiency of the college already exists and that the men who can assume the charge of the new form of administration can be selected from college ranks. One of the first tasks of the association will be to collect and collate the material already existing available for use in standardizing college efficiency, or for formulating and defining new units of internal educational and not merely statutory valuations. At the same time it would put tags upon the men who have already partly solved these problems that they may be available in applying the new methods.

The Higher Education Association believes that a large proportion of the problems which are troubling the colleges are not educational in their nature, but are strictly administrative questions which have arisen and have been solved under like conditions in other human activities. If so, these problems can be most quickly and smoothly solved through the cooperation of the alumni who have successfully solved and are daily coping with similar problems in their own business or professional life, and who are now trustees of colleges or eligible for such positions. My time will not allow me to give further particulars of how the Higher Education Association proposes to bring the alumni into line to help solve the extra-pedagogical problems of the college. It believes that these problems can be solved outside of the colleges themselves; that this work must be done through an organization of the best and best-known bankers, manufacturers, business and professional men, among our alumni, with its own corps of skilled educators and administrative and other experts; that a new form of standardizing of college efficiency which shall take account of the educational values of the personal equation of teachers and taught must be devised, and that a new kind of industrial engineers for college affairs must be trained and offered to the colleges.

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WHAT SPECIALIZATION HAS DONE FOR PHYSICS TEACHING[1]

In his presidential address before the British Association last summer Sir J. J. Thomson, speaking of overspecialization at Cambridge University, said:

> Premature specialization injures the student by depriving him of adequate literary culture. . . . It retards the progress of science by tending to isolate one science from another. The boundaries between the sciences are arbitrary, and tend to disappear as science progresses. The principles of one science often find most striking and suggestive illustrations in the phenomena of another.

It is time to inquire whether early specialization among undergraduates in American colleges is unfitting them both for research and for teaching. The theory still prevails in college that it is good to know more than one thing, otherwise there would be no minors, but minors, according to our closely differentiated scheme, are little else than divisions of the major subject. The result appears to be that we are producing graduates whose outlook is too limited to enable them to carry on a piece of original research. They become research assistants with little prospect of ever being very successful at independent work.

L. H. Baekeland in SCIENCE, Vol. 25, p. 845, says:

> I challenge you to name any truly great man who was merely a specialist. . . . One-sided pursuits are apt to make us very narrow-minded. . . . Overspecialized science is apt to degenerate into a mere hobby where all conception of true proportions and harmony are lost.

The evil of early specialization is particularly apparent when we consider the cause of education—especially that within the college walls. Not only has the regime signally failed to qualify young men for teaching, but there has grown up along with it a distaste for and even a disrespect for teaching. There are about 150,000 undergraduate students who annually contract with the colleges of the land for instruction, but no one seems to want to teach them. The colleges announce a full staff of instructors—the title still remains—but it is difficult to find a college instructor, educated within the last ten or fifteen years, who makes it his chief interest to teach or who likes to acknowledge that it is his chief business. When asked what he is doing he tries to think of some little piece of research, however insignificant, and he shows impatience and evident embarrassment if obliged to say that he is engaged chiefly in teaching.

President Hadley of Yale, speaking at Johns Hopkins University, February 22, 1909, on "The Danger of Overspecialization," said:

> It is not enough to discover truth, we must make it known among the citizens of this self-governing commonwealth. The college is ceasing to have the influence which it ought to have upon the world.

From the New York *Times*, December 20, 1909:

> President Lowell, of Harvard, has expressed himself as heartily in favor of bringing the college course nearer to the practical concerns of the community. "A university," he says, "to be of any great value, must grow out of the community in which it lives and must be in absolute touch with the community, doing all the good it can and doing what the community needs. Any institution which is not in absolutely close touch with the community about it is doomed to wither and die."

New York state, which is typical, has about 800 high schools and probably there are not a dozen teachers outside of New York City who are employed in these high schools to teach physics alone. Still, when a young man goes to college with the intention of fitting himself to teach in one of those high schools he is compelled to

[1] Read before sections B and L, Boston, December 31, 1909.

choose a major subject, and if it be physics, for example, his adviser will steer him through a course so highly specialized in physics and so devoid of other things that he is quite unfit to teach anything, and especially a general beginners' course. Among the courses in physics which he takes none will have reference to the experiences of life, but each will be a distinct attempt to prepare for the next technical course beyond. Even if his duty was to teach physics alone he would not know enough about chemistry and other allied sciences to teach physics properly. But what does the college course do for the 750 high schools of New York state in which one person has to teach all the sciences? Or what does it do for the 570 high schools which have only three teachers, or less, apiece, and in which some one has to teach more than all the sciences? No one, however, can visit many of these schools without reaching the conclusion that some of them have excellent physics teaching. In some cases the credit for this is due to the state normal schools, and in some schools the physics teaching appears to be good because they are not trying to fit for college.

One can not read the papers of to-day without feeling that the community is on the point of making great changes in its educational institutions. It appears to want undergraduate students to take general courses in several sciences. It wants these courses to be far more general than any courses now are. It will doubtless insist that these courses shall be given by men who can teach, and who are willing to devote their best efforts to it. A generation or so ago the greatest men in all the colleges were great teachers. With the establishment of universities and the encouragement of research came the decadence of teaching. It is to be hoped that both research and teaching will be fostered in the future. If, however, things go on as at present it seems probable that the revival of teaching will be brought about by separating the research function from that of teaching.

Our present scheme of science teaching was founded upon educational theories which are not now entertained. We thought that by drill we could develop certain faculties which would functionize in other fields when called upon to do so. Whatever faculties the college teacher thought his pupils ought to have, these he made it the duty of the high-school teacher to produce. We thought high-school pupils might be trained in observation, in accuracy, etc. We thought they might be equipped with a catalogue of fundamental principles and laws, the use of which might appear when they got to college. We thought it possible to teach one single science *thoroughly*, and we said much about teaching pupils to be scientific by concentration upon one thing and we spoke slightingly of the general courses. It now seems probable that a man trained to conservatism in one field is no less likely to be a wild-cat in some other field. It has been pointed out that in matters of education, and particularly in the matter of prescribing work for the high schools, the college physicists have been strangely unscientific; dealing with snap judgments when reliable data were not at hand; prescribing out of ignorance where a council of doctors would have been baffled. Who knows that the high school pupil has reached the time of life when he can be trained in exact science without doing him violence? The community wants its young people informed about the interpretations which may be put upon the phenomena and experiences of daily life. The attempt to make pupils scientific before their time

may prevent their ever becoming scientific. Intolerance of those who have the gift of imagination may lead one to try to suppress a Davy or a Maxwell.

Public dissatisfaction with the teaching of to-day is expressed by many. Let me quote a few.

L. B. Avery, of California:

Physics is the most fundamental in its conceptions and the most practical in its applications of all the sciences. The proposition to leave any portion of those who take a complete high school course with no knowledge of it is in itself a complete acknowledgment of the educational inadequacy of the present methods.

L. H. Bailey, of Cornell:

Distinguish between the teaching function and the research function. We are teachers. It is our business to open the minds of the young to the facts of science. . . . Nature study is a new mode of teaching, not a new subject. It is just as applicable to the college as to the common school. . . . We should be interested more in the student than in the science.

T. M. Balliet, of New York University, in *School Review*, Vol. 16, p. 217, has an exceedingly good article, but too long to quote, on "The [evil] Influence of Present Methods of Graduate Instruction on the Teaching in Secondary Schools."

W. S. Franklin, of Lehigh:

My experience is, most emphatically, that a student may measure a thing and know nothing at all about it and I believe that the present high school courses in elementary physics in which quantitative laboratory work is so strongly emphasized, are altogether bad. . . . I believe that physical sciences should be taught in the secondary schools with reference primarily to their practical applications. . . . I can not endure a so-called knowledge of elementary science which does not relate to some actual physical condition or thing. . . . Either you must create an actual world of the unusual phenomena of nature by purchasing an elaborate and expensive equipment of scientific apparatus, or you must make use of the boy's everyday world of actual conditions and things.

David Starr Jordan, of Leland Stanford University:

For colleges to specify certain classes of subjects regardless of the real interest of the secondary schools and their pupils is a species of impertinence which only tradition justifies. . . . In general, the high-school graduate who has a training worth while in the conduct of life is also well-fitted to enter college for further training. The average American boy quits the high school in disgust because he can not interpret its work in terms of life.

S. V. Kellerman:

Only by teaching honestly what the world needs, and can use, may the schools accomplish their lofty aims.

No one has stated the dissatisfaction with present practises more justly than Principal W. D. Lewis in the *Outlook*, December 11, 1909, in an article entitled "College Domination of High Schools," from which I make an extract or two.

The high school is failing in its mission because its methods and scope of instruction are determined by college entrance examinations made by specialists whose point of view is not the welfare of the student, but the (supposed) requirements for advanced study of certain subjects. . . . Our present college-dictated high-school course is ill adapted to the real needs of the people in that it places the emphasis on the wrong subjects, and practically eliminates those that would be of the greatest practical value in the lives of the vast majority of pupils whose only opportunity for higher education is in the public high school. No less destructive of the welfare of the masses is the limitation in method of treatment of the subjects taught. . . . College teachers have written the courses, trained the teachers, set the examinations and execrated the results.

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FOUR INSTRUMENTS OF CONFUSION IN TEACHING PHYSICS[1]

THE college entrance requirements in physics have been such, at least up to the time of the recent modifications, that it has

[1] Read before Section L, Boston, 1909.

been practically impossible to meet them in any satisfactory manner in schools in which, as is the case, for instance, in the free high schools of Wisconsin, the subject is almost universally a required one. Even the new requirements are still so largely quantitative in their spirit that there is great room for doubt as to the advisability of attempting to prepare for college unless the doubtful practise, so commonly being adopted, of making the college preparatory an elective course is to prevail. This would mean that if pupils are to be given to any adequate extent the wider view of life and its relations, with a permanent interest in the natural phenomena about them, separate classes must be formed whose work will not count as a preparation for study in a higher school.

The results up to this time of the attempts to give to all students a general course which would meet the two purposes have been far from satisfactory from the standpoint of either life or the college. Neither interest nor ability has, as a rule, been developed. Even in schools having special preparatory classes the subject is elected by comparatively few and the number taking it because they really like it, is much smaller still. On the other hand, the attempt to make the general class meet the requirements has resulted in very imperfect ideas coupled too often with an actual dislike of anything related to the distorted meaning attached to the word physics.

I will illustrate by describing a typical case. A young lady with whom I am well acquainted was studying physics, not in the backwoods, but in a large school in the shadow of what is by common consent considered a great university. The class was in charge of a well-educated young man who has since been promoted to a still better position. In conversation with the young lady I asked her to tell me in plain English the meaning of specific gravity. To make the question more concrete I used a piece of wood as an illustration, and asked what is meant when we say its specific gravity is .6. She began by giving me correctly the formal definition: "Specific gravity is the ratio, etc." This was not plain, every-day, common English. Then she told me how to find specific gravity. This would have no meaning to a person who had never studied physics. She finally gave up in despair, and I suggested that the expression meant simply, in the case under consideration, that the piece of wood weighed .6 as much as the same bulk of water. In almost astonishment she declared that she had never thought of it in that way before.

Judging from the answers to this and many similar questions received from hundreds of pupils I feel that I am safe in saying that this was a case typical of the large majority. The student was, I think, certainly up to the average in ability to comprehend physics, and she had a natural liking for the subject. At any rate, she can now talk intelligently of the carburetor, throttle and needle valves, fly wheel and mixture of air and gas of the motor of her launch, and, moreover, the little engine responds more readily to her touch than it does to that of others who might be supposed to be better qualified than she in physics. She even fully appreciates the advantage of the system of pulleys used to lift the door of the boat house. She is now a senior in the university, but her dislike for the study is such that she has refused to elect it in her course, even though she might have taken it under one of the most skilful and interesting professors in the whole country. I do not mean to imply that the work is all

poor, but the results as a whole are not nearly what they should be.

Now, in studying the general situation and especially in analyzing the means used in teaching, aside from the influence of the personality of the teacher, I can not help concluding that the great defect lies largely in the misuse of the four great tools of instruction, fine tools in their proper place and used at the proper time, but as used in our high schools under the conditions existing in Wisconsin, at least, turned to what may be fitly called instruments of confusion. These instruments are:

1. *Measurement.*—Undue emphasis is placed upon accurate measurement, especially with delicate and complicated apparatus. I suppose that in the case described above the pupil had been put through the usual course. There was first some brief introductory work, mainly by the teacher, with little attempt to make use of what the student already knew of the subject. Instead of some roughly approximate measurements using a familiar spring balance, a large block of some substance and a tank of water, she was probably given a carefully adjusted balance, a small bit of some material, and required to make from ten to twenty weighings, to average the results, and to write the whole according to a prescribed form in a notebook. She was fortunate if the time of the instruction and the time of the laboratory work were not some days or even weeks apart. By the time all this was done the poor little bit of physics involved was pretty effectually lost in the maze of manipulations and averages. It may have been excellent manual-training work, but it should have been done in that department.

Laboratory work is necessary, more necessary in these days of specialization than ever before, not as a specialist's instrument in the high school, but as a means of giving clearer conceptions of the topics studied, including supplying information which in earlier days would have come to the pupil as a part of his own experience. Much of physics which a generation or two ago was within the observation of the pupil in its entirety is now largely obscured. For instance, in the case of the water supply. Then the boy saw the well dug, the pump and piping installed, and the water obtained by the application of force; now he sees only the faucet. Then, the periodical candle making from tallow produced on the farm was a somewhat exciting event, upon the success or failure of which meant a good or poor supply of light for the winter evenings; now, a button is pushed and the light comes without further question. The chain back to the source must be supplied by the laboratory work, a large part of which still should be outside of school.

2. *The Mathematical Work.*—The average exercise in the texts most in use when analyzed reveals a very small amount of physics in proportion to the mathematics involved. It would make excellent material for a parallel advanced class in mathematics, either algebra or geometry, or a combination of the two. I am hoping to see the experiment tried of having such classes conducted, if possible, by the teachers of physics, but such work should not take the time of or be called physics.

Physics is a quantitative as well as a qualitative study, and we must use some mathematics; but in my experience, both as a teacher and as an inspector, I have found that the mathematics must be very simple, and that round numbers, or very simple fractions, must be generally used if the pupil's mind is to be kept clear for the physical principle. The experiment illustrating Boyle's law will be much

clearer if the confined gas be reduced to approximately a half, a third, or a quarter, than if a smaller or a more closely accurate measurement be attempted.

3. *The Formula.*—Over and over I find pupils using formulas and securing correct answers to problems without any definite comprehension of the meaning of the formula, the principles and phenomena involved, or of the answer obtained. I might give many illustrations drawn from experience, but he is a fortunate and an excellent teacher who can not secure illustrations by asking his own pupils for explanations in clear, understandable, everyday English. Teachers do not appear to realize that a formula is an instrument to save thinking, and that its use very soon becomes purely mechanical, as in the case of any rule-of-thumb process. In the hands of a beginner it is a dangerous tool if he is expected to become an intelligent, independent man rather than a mere workman.

4. *Technical Terms.*—These employed to the usual extent are the most dangerous of all instruments in their possible effects. More time is wasted in science classes in mere dictionary work than one can realize unless he has had opportunity for extended observation. Instead of starting with the phenomenon, the thing itself, and gradually reaching a point of understanding such that a single word may be used instead of a group to express a thought and still keep the thought in mind, the teacher is all too likely to begin with the technical word and attempt to work backward in getting at the idea. Here again is the failure to understand that the symbol is a time-saving device, and that it is utterly useless without the clear idea always back of it. The accumulation of the mass of technical terms in the most of our secondary science teaching is almost appalling, and it is no wonder that so many pupils emerge at the end of the study in the bewildered condition indicated by the examination tests.

Physics is a study most wonderful in its possibilities, and I sincerely hope that in the near future the work may be so modified that its usefulness will appeal to our students so strongly that we may be able to resist the demand that it be made an optional study.

The average American young person is very unwilling to give up what he considers his birthright, the opportunity for a higher education; and he submits to much that is distasteful and to much which he instinctively feels is inappropriate or useless rather than to forfeit a chance of satisfying what may be an ambition in the future. Must it continue necessary, in order to fit for college, that the four great instruments for giving that preparation shall continue to be "Instruments of Confusion"?

H. L. Terry

State Department of Education,
Madison, Wis.

THE RESIGNATION OF PRESIDENT NEEDHAM

Dr. Charles W. Needham has resigned the presidency of George Washington University. In his letter to the trustees he says:

> After eight years of service as president I offer my resignation of this high office. This I do from a keen sense of personal loyalty to the institution. Difficulties have arisen which, in my own opinion and in the opinion of some of my friends in whom I have the greatest confidence, can only be solved by a man coming to this office who can undertake the task free from all connection with the past. It therefore becomes my duty to make clear the way for the appointment of such a man.

In accepting the resignation the trustees passed the following resolution:

> *Resolved,* That the resignation of Dr. Charles Willis Needham as the president of this univer-

sity, presented to this board by his letter of resignation at the meeting held on April 27 last, be and the same is hereby accepted, to take effect on August 31, 1910.

Resolved, That in accepting the resignation of Dr. Needham, the trustees desire to express their high appreciation of his intelligent and laborious services in upbuilding the university and raising its standards, and their regret that it has now become necessary, in his opinion, for him to relinquish into other hands the guidance of the affairs of the institution, in the management of which he has for the past eight years participated jointly with the other members of the several boards of trustees. In all these years he has labored with an eye single to the highest good of the university and with a clear conception of its usefulness to the national capital and therefore to the nation. He has shown great intelligence, unselfish devotion, fine courage, patience and manly courtesy even under the most trying circumstances. They extend to him as he is laying down the heavy burdens of the high office which he has held, their sincere good wishes.

They further desire to place on record their concurrence in the policy of keeping the institution up to the rank of a university, and their belief that the educational organization formed under his direction is a substantial foundation upon which to establish a university adapted to conditions at the seat of government.

SCIENTIFIC NOTES AND NEWS

THE subject of Mr. Roosevelt's Romanes lecture, to be given at Oxford, will be "Biological Analogies in History."

DR. EDWARD M. GALLAUDET, for the past fifty-three years president of the Columbian Institution for the Deaf and Dumb, commonly known as Gallaudet College, has resigned as president of the institution, his resignation to take effect on September 15. Dr. Gallaudet was born on February 5, 1837.

A TESTIMONIAL dinner in honor of Dr. James Tyson was given in Philadelphia on May 5, on the occasion of his retirement from the professorship of medicine of the University of Pennsylvania.

DR. WILLIAM H. PARK, professor of bacteriology and hygiene in the University and Bellevue Hospital Medical College, has been given the degree of doctor of laws by Queen's University at Kingston, Ont.

THE Samuel D. Gross prize of the Philadelphia Academy of Surgery for 1910, amounting to $1,500, has been awarded to Dr. A. P. C. Ashhurst, of Philadelphia, for an essay entitled, "An Anatomical and Surgical Study of Fractures of the Lower End of the Humerus."

WE learn from *Nature* that the Geological Society of France has this year awarded its Danton prize to M. Gosselet. The prize is given to the geologist whose discoveries are likely to benefit industry most, and was awarded to M. Gosselet for the part he has taken in the development of coal-mining in the north of France. The Viquesnel prize, intended to encourage geological research, has been awarded to M. Robert Douvillé for his stratigraphical work on the geology of Spain and his paleontological researches on the foraminifera and ammonites.

THE *Medical Record* calls attention to the fact that with the assumption by General Leonard Wood, of the office of chief of staff of the U. S. Army and the advancement of Major-General F. C. Ainsworth to become ranking major-general, the two highest positions in the army are held by physicians who entered the line from the medical service. General Wood was graduated from the Harvard Medical School in 1884. General Ainsworth was graduated from the medical department of the New York University in 1874.

THE association medal of the National Association of Cotton Manufacturers was awarded at its eighty-eighth meeting, on April 27, to Dr. C. J. H. Woodbury for his Bibliography on the Cotton Manufacture, and also for services to this industry. This medal was established in 1895, and the act governing its award states: It is the purpose of the board of government that this medal may be given to any person whose work has been, in their opinion, and advantage of sufficient importance to the purposes to which this organization is devoted in its broadest sense, in-

cluding any papers read before the association, the production of any mechanism or processes in the fabrication, design, or finishing of cotton goods, comprising mill construction, the generation of power and its distribution, or any of the works tributary to the cotton manufacture.

E. P. Meinecke, Ph.D. (Heidelberg), has accepted a position as expert in the Office of Investigations in Forest Pathology in the Bureau of Plant Industry. This office, as organized at present, consists of: Dr. Haven Metcalf, pathologist in charge; Drs. George G. Hedgcock and Perley Spaulding, pathologists; Carl Hartley and E. J. Humphrey, assistants; Dr. E. P. Meinecke, expert.

Mr. Theo. Kryshtofovich, of the Russian Government Agricultural Commission, is visiting America for the purpose of finding out what American agricultural methods, machinery and plants it would be worth while to introduce into the Russian steppes. He has been particularly interested in the hardy American fruits. He makes his headquarters at 3059 Magnolia Avenue, St. Louis.

Dr. E. Lindhard, director of the Royal Agricultural Experiment Station at Tystofle, Denmark, and Dr. Kølpin Ravn, professor of plant pathology in the Royal Agricultural College of Copenhagen, are visiting America for the purpose of studying American methods of forage crop production and applications of plant pathology.

Mr. Frank M. Chapman, of the American Museum of Natural History, and Mr. Louis Fuertes, have returned from an ornithological expedition to the West Indies.

Dr. Charles R. Stockard, of the Cornell Medical School and secretary of the American Society of Naturalists, will be at the Naples Zoological Station till the first of August.

Dr. R. R. Gates has sailed for Europe to attend the International Botanical Congress at Brussels as a representative of the Missouri Botanical Garden and the St. Louis Academy of Sciences.

Professor E. B. McGilvary, of the department of philosophy of the University of Wisconsin, was elected president of the Western Philosophical Association at the recent meeting at the University of Iowa.

The eighteenth James Forest lecture of the Institution of Civil Engineers will be delivered in London, on June 22, by Sir John Gavey, C.B., on "Recent Developments of Telegraphy and Telephony."

The Research Club of the University of Michigan held a memorial meeting on April 20 to commemorate the centennial of Dalton's "New System of Chemical Philosophy." The program was as follows: "John Dalton and his Achievement: A Glimpse across a Century," by Professor R. M. Wenley; "The Atomic Theory," by Professor S. L. Bigelow; "Daltonism to Date," by Professor C. E. Guthe.

The Society for Philosophical Inquiry, of Washington, D. C., held a memorial meeting at the George Washington University, on May 3, in honor of the late Dr. William T. Harris, formerly U. S. Commissioner of Education. The program was as follows:

"The Genesis of the Philosopher," Rev. Dr. J. MacBride Sterrett.

"His Philosophy," Edward E. Richardson, Ph.D.

"Dr. Harris as U. S. Commissioner of Education," Dr. Elmer Ellsworth Brown, U. S. Commissioner of Education.

"Dr. Harris as Interpreter of Dante," Rev. Dr. Frank Sewall.

"Impressions of Dr. Harris as Teacher of Philosophy," Rev. Dr. U. G. B. Pierce.

Address by ex-Governor John W. Hoyt.

Address by Rev. Dr. Samuel S. Laws.

Walter Craig Kerr, president of Westinghouse, Church, Kerr and Company, previously assistant professor of engineering in Cornell University, of which institution he was a trustee at the time of his death, died on May 8, at the age of fifty-two years.

Dr. Julius Kühn, until recently professor of agriculture at Halle, has died in his eighty-fifth year.

Dr. Eugene Hodenpyl, formerly adjunct professor of pathological anatomy in the College of Physicians and Surgeons of Columbia

University, died on May 5 at the age of forty-seven years.

DR. JULIUS POST, professor of industrial hygiene in the Berlin School of Technology, has died at the age of sixty-four years.

DR. C. B. PLOWRIGHT, formerly professor of comparative anatomy and physiology at the Royal College of Surgeons and known for his work in natural history, especially on the origin of fungi, has died at the age of fifty-one years.

AMONG the New York state civil service examinations to be held on May 28 is one for the position of zoologist in the Educational Department, with a salary of $1,200.

THE senate on May 2 amended and passed a bill which already had passed the house to create a Bureau of Mines in the Interior Department. In addition to carrying on mining work heretofore done by the Geological Survey, the bureau will investigate the causes of mine explosions.

THE prize of the foundation George Montefiore, of the value of about $4,000, will be awarded for the first time in 1911, for a printed or manuscript work on the technical applications of electricity. Further information may be obtained from the secretary M. G. L'Hoest, Liège, Belgium.

M. DE MONTEFIORE has given 150,000 francs to the Paris Academy of Sciences to establish a triennial prize in electrical science.

AT the University of Illinois an Aero Club has been formed by some twenty-five undergraduates. It intends to affiliate with the American Intercollegiate Aeronautic Association.

MORE than seventy-five international associations are holding a congress in Brussels this week, in connection with the World's Fair. Among them are the Interparliamentary Union, the Institution of International Law, the International Office for Weight and Measures, the International Geodetical Association, the Institut Marey, the International Office of the American Republics, the Nobel Institute and the International Groups of Esperanto.

A PRELIMINARY program has been issued of the International American Scientific Congress to be held in Buenos Aires from July 10 to 25, in celebration of the centenary of the revolution of May, 1810. The sections into which the congress is divided are as follows: Engineering, Physics and Mathematics, Chemistry, Geology, Anthropology, Biology, Geography and History, Economics and Statistics, Military Science, Naval Science and Psychology. Programs and information in regard to the congress may be obtained from the president of the committee of propaganda, care of the Argentine Scientific Society, 269. Calle Cevallos, Buenos Aires.

THE nineteenth session of the Marine Biological Laboratory of the Leland Stanford Junior University at Pacific Grove will begin on June 1. The regular course of instruction will continue six weeks, closing July 12. The investigators and students working without instruction may make arrangements to continue their work through the summer. The laboratory will be under the general supervision of Professor F. M. McFarland.

DURING the months of July and August the facilities of the seed laboratory of the Bureau of Plant Industry, United States Department of Agriculture, Washington, D. C., will be available as far as space permits to any one who wishes to consult the seed collection and become familiar with the practical methods of seed testing for mechanical purity and germination. For further information address Mr. E. Brown, botanist in charge.

THE fourth session of the Graduate School of Agriculture under the auspices of Association of American Agricultural Colleges and Experiment Stations will be held at the Iowa State College, Ames, Iowa, July 4–29. The new hall of agriculture, erected and equipped at a cost of $375,000, will be the seat of activity during the session but the other buildings and laboratories of the departments will be available for instruction. The purpose of the Graduate School of Agriculture is to give advanced instruction with special reference to the methods of investigating agricultural problems and teach-

ing agricultural subjects. Instruction will be given in eight main lines, agronomy, plant pathology and physiology, animal husbandry, poultry, horticulture, dairying, rural engineering, rural economics and sociology. The work of extension departments, such as organization and function, agricultural journalism and conservation of our natural resources will be discussed at sessions particularly arranged for such. At the opening exercises to be held on July 6 addresses will be given by Hon. James Wilson, secretary of Agriculture; Dr. A. B. Storms, president of Iowa State College; Dr. W. O. Thompson, president of Ohio State University; Dr. C. F. Curtiss, dean of agriculture, Iowa State College; Dr. H. P. Armsby, chairman of the committee on graduate study, Association of American Agricultural Colleges and Experiment Stations, and Dr. A. C. True, director of Office of Experiment Stations and dean of the Graduate School of Agriculture. Attendance at the sessions of this school is limited to persons who have completed a college course and have taken a bachelor's degree, except to non-graduates who are recommended by the faculty of the college with which they are associated as properly qualified to take advanced work in agriculture.

UNIVERSITY AND EDUCATIONAL NEWS

THE New York legislature has passed a bill appropriating $357,000 for new buildings for the State College of Agriculture at Cornell University. Of the sum appropriated, $200,000 will be available this year. Three new buildings are provided for—an auditorium to cost $113,000, a poultry building, for which $90,000 is set aside, and a home economics building, whose cost will be $154,000.

THE new engineering building of Union College built by Mr. Andrew Carnegie at a cost of $100,000 and endowed by the alumni with an equal sum, was dedicated on April 28.

MR. JAMES R. STEERS has given the College of the City of New York, from the first class of which he graduated in 1853, $10,000 for the purchase of books on natural history, physics and chemistry and has purchased the library of the late Professor Wolf, of Delaware College, Newark, Delaware, and presented it to the Wolcott Gibbs Library of Chemistry in the college.

BY the will of Edward A. Bowser, emeritus professor of mathematics and engineering, in Rutgers College, who died at Honolulu about two months ago, the college has received a bequest of his library, also the rights to the plates of the printed copies of his various text-books, together with the royalties on them.

IT is announced that a National College of Agriculture is to be established in Pretoria. General Botha has promised to set aside £100,000 as a first installment for the execution of the project, and the Town Council has decided to give the government the whole of the town lands of Groenkloof as a site. The area comprises 3,681 acres.

HARVARD UNIVERSITY has established the new degree of associate in arts, to be abbreviated as A.A. It is understood that Radcliffe College will offer this degree to women. The degree is designed for those who have taken courses provided by the Department of University Extension, whether in the summer school or in the winter courses now being arranged by the intercollegiate "Commission on Extension Courses." It will require the same number of courses as the A.B., but no entrance examinations and no residence at the university.

THE commission appointed by the general assembly of the presbyterian church to confer with the trustees of Queen's University, at Kingston, Ont., in regard to certain changes in the university constitution decided, on a vote of ten to nine, to recommend to the Montreal assembly next June that the report of the joint committee, which met at Ottawa last January, be accepted. This would make Queen's University undenominational in form and enable it to receive the pensions of the Carnegie Foundation.

DR. CHARLES E. PELLEW, adjunct professor of chemistry, and Dr. Ira H. Woolson, adjunct professor of civil engineering, have resigned their chairs in Columbia University.

DR. ARTHUR O. LOVEJOY, of the University of Missouri, has been appointed professor of philosophy at the Johns Hopkins University.

THE J. PIERPONT MORGAN professorship in biology at Trinity College, made vacant by the resignation of Dr. Charles Lincoln Edwards, has been filled by the appointment of Max Withrow Morse, Ph.D. (Columbia), of the College of the City of New York. Dr. Morse will take charge of the work in September. The second professorship in the department, held by Karl Wilhelm Genthe, Ph.D. (Leipzig), who returns to Prussia, will not be filled at present.

IN the Harvard Medical School, Dr. W. R. Brinckerhoff, who for the past four years has been a member of the U. S. Government Leprosy Investigation Commission at Molokai Island, has been appointed assistant professor of pathology, and Dr. S. B. Wolbach, at present director of the pathological laboratory of the Montreal general hospital, has been appointed assistant professor of bacteriology.

DR. H. W. MORSE has been appointed to an assistant professorship of physics, and Dr. L. J. Henderson to an assistant professorship of biological chemistry at Harvard University.

DR. K. T. FISCHER, of the Munich School of Technology, has been called to a chair of physics in the University of La Plata.

DISCUSSION AND CORRESPONDENCE

THE STUDY OF ROCKS WITHOUT THE USE OF THE MICROSCOPE

THE phrase "without the use of the microscope" appears on the title page of two well-known text-books of petrography.[1] In a number of colleges and universities there are petrography or lithology courses given in which rocks are treated entirely from the megascopic standpoint. The writer has no fault to find with the two excellent text-books mentioned, for they may be used in connection with microscopic work; but he does take issue with the method of studying rocks without the microscope.

[1] Kemp, "Handbook of Rocks"; Pirsson, "Rocks and Rock Minerals."

In order to anticipate our critics, let us assume at the outset that the average student has neither the time nor inclination to become an expert petrographer and also that in after life he will not have a polarizing microscope available. In view of these facts why then should the microscope be used in the study of rocks?

In the writer's opinion no one can have an adequate knowledge of rocks until he has studied them in thin sections. What conception of the gradations between rocks, the variations in texture, intergrowths, inclusions and alterations has the student who has never made a microscopic study of rocks? Yet some idea of these things is essential to an understanding of rocks. What does he know about fine-grained rocks such as basalts or the fine groundmass of such rocks as rhyolites? After the student has studied a type collection of rocks, together with the corresponding thin-sections, he is in a position to determine the commonly occurring rocks in hand-specimens because he has worked out thin-sections of similar rocks. In studying the slides he looks for minerals in the hand-specimen that would otherwise escape his notice, and learns to identify them. He has also developed his imagination and can in some measure predict what minerals the rock contains. He will be pretty certain, for example, if the phenocrysts in a porphyritic rock are quartz, that the fine groundmass is a mixture of quartz and orthoclase. A heavy, black, fine-grained rock, he knows, is almost sure to consist of plagioclase, augite, magnetite and more or less glassy base. Black prismatic phenocrysts are either augite or hornblende or possibly a rare pyroxene or amphibole. Of course the student will make mistakes; even experienced petrographers are not infallible. One advantage of the microscopic study is that the student realizes the limitations of sight determination. The added interest and knowledge of rocks gained more than compensates for the time taken up with a short study of optical mineralogy. The lack of time will be the objection raised against my plan, but whatever the time avail-

able, half of it may well be spent in the study of elementary crystal optics so that minerals may be identified in slides. The above remarks apply especially to igneous rocks, as there is less variety in the sedimentaries and metamorphics and the loose nomenclature used for them makes them easier to classify. It may be urged that the broader chemical and geological features should be emphasized, that is, petrology rather than petrography should be taught. The writer is in entire accord with this view, but unless the student makes numerous rock analyses, how better can he learn to appreciate the chemical side of petrography than by a study of slides?

My views on this subject naturally depend somewhat upon my opinion of the recently proposed megascopic or field classification of igneous rocks. One of the serious criticisms applied to the ordinary qualitative classification is the redefinition of rock names. Yet in this field classification we have such names as syenite and basalt redefined to suit the megascopic determination. Perhaps the distinctions made on a megascopic basis are good ones, but terms that do not conflict with ordinary usage are preferable. Such names as leucophyrs are all right, but it seems hardly fair to call an anorthosite a syenite when the plagioclase may be determined at sight, since all its affinities are with the gabbros. It hardly seems reasonable to call a dark-colored porphyritic rock a basalt-porphyry when quartz or orthoclase phenocrysts are visible. Typical andesites can readily be distinguished and it hardly seems necessary to call them felsite-porphyries. The writer believes that the usually accepted grouping of igneous rocks into granites, rhyolites, syenites, trachytes, diorites, andesites, gabbros, diabases, basalts and peridotites is the best one to follow even in megascopic work. Of course one can not always make the distinctions recognized in this classification, but this is also true of any rock classification. Often one is fortunate if he can distinguish an igneous from a metamorphic rock in the hand specimen. One of the principal reasons for studying petrography is that the student may be able to read geological literature intelligently. Even though the ordinary classification is purely qualitative and the personal equation large, yet the names for the common rocks given above are fairly definite in their meaning as used in the literature for the last twenty-five years or so.

In conclusion the writer would summarize his views as follows: The purpose of the petrography course is to give the student a general idea of rocks, to enable him to make rough determinations of rocks at sight, and to help him in the understanding of geological literature. With these things in mind the study of hand-specimens and slides should go hand-in-hand. The student becomes familiar with the common rock types and so can determine other rocks by mental comparison with those he has studied in detail. The usual classification (granites, rhyolites, etc.) is suitable for megascopic determinations and is also the one recognized in the literature.

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SCIENTIFIC BOOKS

The Mutation Theory. Volume I. "The Origin of Species by Mutation." By Hugo de Vries. English translation by Professor J. B. Farmer and A. D. Darbishire. Pp. xvi + 582. Four colored plates and 119 text-figures. Chicago, The Open Court Publishing Co. 1909.

The publication of the German work, "Die Mutationstheorie," by Hugo de Vries, marks an epoch, not only in the history of botany, but of all biological science; and the mutation-theory itself is, in all probability, the most important contribution to evolutionary thought since the publication of Darwin's "Origin." The importance of de Vries's work lies not only in the elaboration of the theory of saltation as an adequate method of the origination of new forms in the organic world, but (and more especially) in removing the entire question forever from the realm of ineffectual debate, and establishing it upon the firm basis of experimentation.

The general outlines of the mutation-theory are now so familiar to biologists that a statement of it here would be superfluous;[1] and yet the literature on the subject since the appearance of the first part of the German edition, in 1900, has so often shown a lack of clear understanding of the details and scope and claims of the theory, and especially, as the translators state (p. vi), of "a detailed knowledge of the contents of 'Die Mutationstheorie,'" that the English translation is most timely and most welcome. Many attempts have evidently been made to debate the questions involved without familiarity with the original work, and hence it may not seem out of place to emphasize here a few cardinal points which are daily becoming more generally correctly understood.

In the first place, "The special problem which the mutation theory seeks to explain is the manifold diversity of specific forms" (p. 45). It has long been recognized that natural selection really explains, not the origin of species, nor even the origin of adaptations, but the elimination of the unfit, and *the persistence of adaptations;* the fact that characters, both adaptive and non-adaptive, specific or not specific, must exist before they can be selected was previously well nigh lost sight of. The mutation-theory, then, seeks to account for *"the origin of specific characters"* (p. 211).

In the second place, "Spontaneous variations are the facts on which this explanation is based" (p. 45), or, "We may express . . . the essence of the mutation theory in the words: '*Species have arisen after the manner of so-called spontaneous variations*'" (p. 165). This marks the fundamental distinction between Darwinism and de Vriesism. For Darwin, specific characters originated, *chiefly* if not entirely, by the selection of fluctuating or continuous variations; for de Vries by discontinuous (*i. e.*, non-fluctuating) variation only. "In order that species may engage in competition with one another it is evidently an essential condition that they should already be in existence; the struggle only decides which of them shall survive and which shall disappear (p. 212).

The struggle which is significant in descent takes place, not between the individuals of the same elementary species, but between the various elementary species themselves (p. 211). The former results in acclimatization and the formation of local races (pp. 92–99 and 211); the latter in the elimination of unfit elementary species. "It is moreover evident that this 'elimination of species' must have weeded out many more than it has preserved. In a word, from the standpoint of the theory of mutation it is clear that the rôle played by natural selection in the origin of species is a destructive, and not a constructive one."

One of the commonest misconceptions of saltation is that the difference between mutation and fluctuating variation is a quantitative one; that mutations are large variations. Nothing could be more erroneous. The amount of the change has nothing to do with the question. "Many mutations are smaller than the differences between extreme variants" (of fluctuating variation) (p. 55). Mutations are characterized first, by being entirely *new* features, "In contradistinction to fluctuating variations which are merely of a *plus* or *minus* character (p. 213); second, by the *abruptness* with which they appear, and third, by being *transmitted by inheritance without selection.* "They arise suddenly and without any obvious cause; they increase and multiply because the new characters are inherited" (p. 212). "According to the theory of mutation species have not arisen gradually as the result of selection operating for hundreds, or thousands, of years, but discontinuously by sudden, *however small* changes" (p. 213; italics mine).

Moreover, de Vries has carefully defined the term species as used by him. This was never done by Darwin. There is evident need to emphasize this, for in many controversial papers it has been entirely overlooked, the critics meaning one thing by the term, de Vries

[1] Such a statement has previously been given in a review of de Vries's "Species and Varieties: their Origin by Mutation," *Plant World*, 8: 86, 110, 135, 159. 1905.

and his followers quite another. Therefore, it is of prime importance to keep in mind the fact that with the species of the systematist the mutation theory has primarily nothing to do; and this fact is specifically stated. Thus, on page 165:

In order to be qualified to discuss this question we must first of all make quite sure what we understand by the term "species" and, more important still, we must form a clear idea as to which forms we are going to regard as the units of the natural system. For it is only in the case of the *real* units of the system that we can hope to obtain experimental proof of their common descent: the theory of Descent as applied to groups of these units is, and will probably always remain, a comparative science.

And again, on page 168, it is insisted that:

The ordinary Linnean species of the systematist . . . are artificial groups whose limits can be altered by the personal taste of any systematist and are indeed, as a matter of fact, much too often so altered. *The origin of such a species, like that of a genus, is a historical occurrence and it can neither be repeated experimentally, nor can the whole process be observed.* (Italics mine.) The object of an experimental treatment of these phenomena must assuredly be to make the origin of the units which really exist in nature the subject of experiment and observation. *We must deal not with the origin of the groups made by the systematist, but with those which are presented by nature.* (Italics mine.)

Thus the long-standing argument against organic evolution, that no one ever observed the origin of a species (of the systematist), is frankly acknowledged, but clearly shown to have no special significance for the theory of Descent. The elementary species, "those which are presented by nature," "do arise in the garden and in agricultural practise" (p. 169). This is no longer a debatable question.

It is absolutely essential clearly to understand the above points in order to discuss the mutation theory, or to undertake investigations in experimental evolution. It is worth repeating that, "The solution of this problem must . . . be sought among the facts themselves" (p. 462). As to whether mutations are realities or figments of imagination, no one is competent to hold an opinion who has never carried through a series of pedigreed cultures, or observed the results of such work.

Contrary to the implication of so many of his adverse critics, the author has tried to keep as close to Darwinian theory as the facts would permit. Throughout the book (cf., *e. g.*, pp. 51, 87, 198, 205) there has been a constant endeavor to give full credit to the great master, and to present the mutation theory, not as an alternative to natural selection, but as a supplementary hypothesis. Not Darwinism as a whole, but only the formerly baffling and embarrassing difficulties of Darwinism are explained away.

A perusal of the book before us recalls a list of many important and positive contributions rendered by the author through this and his numerous other related writings.

1. The application of the experimental method to the question of the origin of specific characters. This is justly regarded by de Vries as "the most important general result" of his work (p. 497).

2. The development of the method of pedigree-culture.

3. Making clear the fundamental distinction between fluctuation and saltation (mutation), and showing its prime importance. Just as Darwin was not the first to suggest natural selection, so de Vries was not, by any means, the first to draw the distinction between continuous and discontinuous variations (cf. p. 63); but, as was the case with Darwin, he stated the distinction so clearly, demonstrated it so convincingly, established it so firmly upon a wide range of facts, as to bring it into the focus of attention of all biologists, and compel them to reckon with it in all subsequent work.

4. Recognition of character units and of unit characters, and their significance; a principle fully developed in his "Intracellulare Pangenesis."

5. Actual observation of the origin of new plant-forms of the value of elementary species.

6. A resurvey of the vast literature of horticulture and experimental breeding, with a new interpretation of the facts in the light of a new working hypothesis (mutation).

7. Clearly stating, and securing general recognition of the difference between the origin of a character and its selection.

8. Formulation of the working hypothesis of pangenesis. *This was the parent-idea of the entire mutation-theory.*

9. Elaboration of the mutation-theory.

10. The unfolding of new problems and of entire new fields of research. The influence of the mutation-theory (like Darwin's "Origin") amounts to little less than a rejuvenescence of all biological science.

The English translation has had the advantage of the author's careful revision and correction, and embodies certain changes made necessary by Nilsson's work on the selection of cereals.

The second volume of the German original is in process of translation and will be eagerly awaited. Some of the more technical chapters of this volume, relating to hybridization, will be omitted and their translation published separately.

English-speaking botanists and zoologists owe a debt of sincere gratitude to Professor Farmer and Mr. Darbishire for rendering so invaluable a book into their native language. The press work is also commendable, and we should appreciate the willingness of the publishers to undertake the publication of so extensive a work of this character. It is easier to get this done in almost any other country than in the United States.

C. STUART GAGER
DEPARTMENT OF BOTANY,
UNIVERSITY OF MISSOURI

The Story of the Submarine. By Colonel CYRIL FIELD, R.M.N.I.

This is a popular review of the history and traditions of submarine warfare and navigation from the earliest ages to the present day. The manner of presentation is well conceived and the illustrations are sufficient, without going too far into detail. The traditional part appears to be drawn from medieval marvel mongers who never missed a good story nor spoiled it by leaving out picturesque details. But by the second chapter the author takes up his history in which he is precise and conscientious. In the middle of the seventeenth century real submarines were built and navigated, but the progress was slow and intermittent, since they were almost all made of wood and propelled by hand, even so late as the middle of the nineteenth century. The form of the submarine and the difficulties of submarine navigation were by that time fairly well understood, but the lack of mechanical propulsion made the increase of size of little avail.

The author's strict adherence to chronological order fails to throw into relief the really essential features of the development of submarines, such as the chemical generation of oxygen by Payerne, the application of steam power by Garrett and the introduction of the storage battery by Goubet. In the same way the development of the submarine in France and in America loses connection from the fact that first one and then the other comes up for discussion.

The modern submarines appear to be possible on account of the combination of the internal combustion engine (used by Holland), the storage battery, together with devices for controlling direction and submersion. Each of them is described in its proper place, but the reader is left to recognize the combination. In like manner the submarine torpedo is described as the proper weapon of the submarine, but its direct influence on the development of the submarine, due to the perfection of control of the torpedo, is not mentioned.

The author's description of the submarine of to-day is sufficient for his "man in the street," and one may charge to official secrecy and rapidity of development his failure to distinguish clearly between submarines and submersibles and why the latter have been developed to such a displacement of 1,000 tons with a speed of sixteen knots at the surface. His conservative estimate of the importance of the submarine and of its use for other than warlike purposes must be respected.

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SCIENTIFIC JOURNALS AND ARTICLES

The contents of the *American Journal of Science* for May are as follows: "Contributions to the Geology of the Grand Canyon, Arizona.—The Geology of the Shinumo Area," by L. F. Noble (Part I.); "Additions to the Pleistocene Flora of Alabama," by E. W. Berry; "Application of Potassium Ferricyanide in Alkaline Solution to the Estimation of Arsenic, Antimony and Tin," by H. E. Palmer; "New Cystid from the Clinton Formation of Ontario—Lepadocystis clintonensis," by W. A. Parks; "New Petrographic Microscope," by F. E. Wright; "New Ocular for Use with the Petrographic Microscope," by F. E. Wright; "Behavior of Crystals in Light Parallel to an Optic Axis," by C. Travis; "Some Simple Improvements for a Petrographical Microscope," by A. Johannsen; "Natural Naphtha from the Province of Santa Clara, Cuba," by C. Richardson and K. G. Mackenzie; "Intrusive Granites and Associated Metamorphic Sediments in Southwestern Rhode Island," by G. F. Loughlin.

SPECIAL ARTICLES

THE CRITICAL SPARK LENGTH

Removing the condensers from the influence machine in order to avoid strong disruption discharge, the insulated metal sheet referred to in a former communication[1] placed between the terminals, separates the positive column from the Faraday dark space. In these two regions the mica wind-mill shows that the air-column is moving in opposite directions. In the dark space Franklin's fluid is carried by convection. The air molecules are overloaded. They flow from the cathode knob to the plate, to which they deliver their charge. On the positive side of the plate the air molecules have everywhere a less than normal charge. Franklin's fluid has been drained out of them and into the anode. The discharge here involves a transfer of Franklin's fluid (Thomson's corpuscles) from molecule to molecule. This operation is attended by luminous effects. Here the convection air current and the electrical discharge are moving in opposite directions. If the metal plate be removed, the opposing air currents will mingle. The length of the Faraday space, where the discharge is mainly by convection will now in general have changed. It becomes less sharply defined.

If the anode knob is moved up to the Faraday dark space, we have the critical spark length when disruptive discharge is feeble on account of small capacity.

If the knobs are brought nearer together, the positive or luminous discharge surrounds the Faraday region where convection prevails. A further decrease in the distance between the knobs increases the cross section of the column where the non-luminous convection-transfer occurs. The luminous discharge is crowded out into longer arc-like paths. This luminous column is what is usually called the discharge. The air current here forms a return for the convection currents within the Faraday dark space. All of these phenomena have been studied in open air, and photographic evidence will be presented in a paper to be at once published by the Academy of Science of St. Louis. Canal-ray effects obtained when the metal plate is provided with an opening have also been photographed. The Hittorf tube referred to by Thomson[2] is a most striking illustration of phenomena which are above described. In the shorter branch the dark convection discharge involves a transfer of gas molecules which in this case forms, with the gas-flow in the longer branch, a continuous circulation around the circuit of the two branches.

Francis E. Nipher

[1] April 22, p. 628.

[2] "Conduction of Electricity through Gases," 2d ed., p. 443.

THE SAN LUIS VALLEY, COLORADO[1]

Popularly the San Luis Valley or park is supposed to be the southernmost one of a chain of four great parks, of which North, Middle and South parks are the others. In

[1] Published by permission of the director of the United States Geological Survey.

reality, the southern continuation of that series is found in Wet Mountain Valley and Huerfano Park, occupying a depression between the Front Range and Wet Mountain axis and the Mosquito Range and Sangre de Cristo axis, whereas the San Luis Valley occupies a depression west of the latter axis, and between it and the Sawatch Mountains. Furthermore, the former depression began to take shape much earlier—as far back as the Triassic at least—and has been subject to sedimentation more or less continuously from that time until the Pleistocene, whereas the San Luis Valley shows no formations older than Miocene Tertiary, and is for the most part occupied by late Tertiary or early Quaternary sediments.

In the San Luis Valley there may be distinguished two classes of more or less unconsolidated gravels, sands, and clays, an older series of conglomerates with intercalated lava flows, known as the Santa Fe formation, after Hayden, and a younger overlying series of blue clays with interstratified sand beds.

Alamosa Formation.—For the younger upper series of blue clays with interstratified water-bearing sand beds, which occupies the bottom of the valley proper, the name Alamosa formation is here proposed, from the town of that name near the center of the valley.

SECTION OF HANSEN'S BLUFF

	Feet
Gravelly slope	4.0
Conglomerate, indurated sandy clay matrix	4.0
Fine gravel and sand, loose	3.5
Fine-grained reddish sand	2.5
Black and red sand	0.5
Drab joint clay with a great many white indurated nodules	1.5
Coarse indurated sand and small quartz pebbles	4.0
Buff to light-drab sandy clay	10.5
Fine and coarse sand in laminæ	5.5
Olive-green sandy joint clay, with shells	2.5
Banded drab sand with clay pockets	1.0
Fine and coarse pebbly sand in indurated laminæ	4.5
Loose black sand	1.5
Fine banded clayey sand	1.5
Coarse sand and clay with quartz pebbles	2.5
Débris slope to river	12.0

The low relief of the valley region renders natural exposures of the Alamosa formation very scarce, the best one being afforded by Hansen's bluff on the east bank of the Rio Grande, nearly east of the Peter Hansen ranch house, and about eight miles southeast of Alamosa.

Wells in the trough of the valley, at Alamosa, east of Mosca, and at Moffat, which penetrate the Alamosa formation to depths of from 1,000 to nearly 1,300 feet, show alternations of blue clay, fine sand with some gravel, and, occasionally in depth, boulders. The water-bearing beds of sand are found at intervals of twenty to thirty feet, separated by beds of blue clay. The depth of the first sand yielding a flow at the surface varies with the amount of water drawn from that bed, being greater near the regions of denser population and in the central portion of the valley. The flows from the different water-bearing sands are of different pressures and volumes, depending on the depth and thickness of the sand beds. Through these variations it is possible to correlate the sand beds for considerable distances in a region where the wells are numerous, and so to establish the continuity of the beds.

The Alamosa formation is readily shown to lie unconformably upon the Santa Fe formation though the contact along the west margin of the valley is everywhere concealed by the long, gravelly, alluvial slope. There is stratigraphic discordance shown by the fact that the lava flows intercalated in the Santa Fe formation dip toward the valley at an inclination averaging 10°, while the sand beds of the Alamosa formation slope toward the center of the valley with an inclination of less than 1°. In the western and southern parts of the valley several isolated hills composed of the Santa Fe formation project upward through the Alamosa formation. The latter formation abuts directly against the Santa Fe formation in the San Luis Hills at the southern end of the valley. These hills and outliers exhibit a much older topography than the younger valley formation.

The age of the Alamosa formation is

either late Pliocene or early Pleistocene. It has been shown to be separated from the Santa Fe formation, of Miocene age, by an important erosion interval. It can be shown to be preglacial on stratigraphic grounds. Alluvial fans and slopes are widely developed about the sides of the valley. The great Rio Grande fan occupies a fourth or more of the whole valley bottom. The water-bearing sands conform to the contour of the fan, showing that it was developed contemporaneously with the deposition of the formation. Likewise on the east side of the valley the alluvial fans and slope of the Sangre de Cristo range blend and are contemporaneous with the sands and clays of the Alamosa formation. The Pleistocene valley glaciers of the west side of the range just reached down to the alluvial slope and their concentric terminal moraines surmount the crests of the alluvial cones, spreading out from the valleys as the author has previously noted.[3] The sediments of the fans and of the Alamosa formation are therefore preglacial. The valley glaciers of the Rocky Mountains of both the earlier and later periods of glaciation are regarded as rather late Pleistocene. The best age determination that can be made from a stratigraphic standpoint, therefore, is that the Alamosa formation is either late Pliocene or early Pleistocene. Four species of fresh water shells collected at Hansen's Bluff, in the uppermost strata of the formation, are identified by Dall as a Quaternary assemblage.

C. E. SIEBENTHAL

[3] *Jour. Geol.*, Vol. XV., 1907, p. 15.

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY

THE first annual meeting of the society was held in affiliation with the American Association for the Advancement of Science in the Harvard Medical School, Boston, Mass., December 30 and 31, 1909. The sessions were presided over by Dr. L. R. Jones. The society starts with 130 charter members. Fifty members were in attendance and the meeting was regarded as a great success. The rooms and other facilities provided by the local committee were very satisfactory.

The following officers were elected for 1910:

President—Dr. F. L. Stevens, North Carolina College of Agriculture and Mechanic Arts.

Vice-president—Professor A. F. Woods, College of Agriculture, University of Minnesota.

Secretary-Treasurer—Dr. C. L. Shear, U. S. Department of Agriculture.

Councilors—Dr. L. R. Jones, University of Wisconsin; Professor A. D. Selby, Ohio Agricultural Experiment Station; and Professor H. H. Whetzel, Cornell University.

It is expected that the next annual meeting of the society will be held in conjunction with the American Association for the Advancement of Science at Minneapolis, Minn.

The society empowered the council to undertake the publication of a phytopathological journal if the necessary financial and editorial arrangements could be made.

The membership fee for the year 1910 was fixed at one dollar, with the provision that in case a journal was established during the year an assessment of one dollar more should be levied upon each member to cover subscription to the journal for the remainder of the year.

A letter from the Society for the Promotion of Agricultural Science, requesting the Phytopathological Society to appoint a committee for the purpose of considering the question of affiliation of the two societies was read. The society accepted the request and instructed the president to appoint a committee of three for the purpose. Dr. Chas. E. Bessey, Mr. F. C. Stewart and Dr. John L. Sheldon were designated later.

Upon motion the society voted to direct the president to appoint two delegates as representatives to the International Botanical Congress, which is to be held in Brussels in May. Dr. W. G. Farlow and Dr. C. L. Shear were appointed.

The society also adopted a motion providing for the appointment by the president of a committee of five to draw up rules and make recommendations concerning the common names of plant diseases. The president appointed Dr. F. L. Stevens, Dr. H. von Schrenk, Dr. E. M. Freeman, Mr. W. A. Orton and Dr. G. P. Clinton.

Owing to the recent introduction of two serious plant diseases, the yellow wart disease of the potato, caused by *Chrysophlyctis endobiotica*, and the white pine disease, caused by *Cronartium ribicolum*, into America, the society unanimously adopted a motion directing the president to appoint a committee of five to draft appropriate resolutions regarding these diseases and take

steps to secure such action as would prevent their further introduction and spread. Dr. H. Metcalf, Dr. H. T. Güssow, Professor H. L. Bolley, Professor A. D. Selby and Mr. W. A. Orton were appointed.

A joint session with Section G of the American Association for the Advancement of Science for the reading of papers was held Thursday afternoon, December 30, and two separate sessions were held Friday, December 31. Abstracts of the papers read follow:

Morphology and Life History of Puccinia malvacearum Mont.: Mr. J. J. TAUBENHAUS, Delaware Agricultural Experiment Station.

Morphology.—The mycelium of this fungus is septate, branched and intercellular. It is very rich in oil globules and protoplasm which gives it a red orange color. Haustoria are rarely found. A characteristic mycelial cushion is formed under the epidermis of the host. This cushion is made up of large mycelial threads irregularly interwoven and at the tips of which knobs are formed. Each knob bears from two to five teleutospores, each teleutospore starting as a little bud. The teleutospores are found to greatly vary, in both form and shape. One-celled and three-celled are fairly common, while four-celled teleutospores are found more rarely. The sporidia are formed in two ways: First, the promycelium divides into four pear-shaped bodies which bear the sporidia. Second, the promycelium breaks up into four cells which separate and each cell forms and bears a sporidium.

Life History.—The fungus is carried over winter as developing mycelium, as hibernating teleutospores and with the seeds. Late in the fall young sprouts are formed at the base of the hollyhock. These soon become infected. The plants are covered up with a mulch to protect them from the cold. The young sprouts grow considerably under the mulch. During late fall the leaves do not show evidence of infection. This becomes evident during the winter when the young sori appear as white dots which become more yellow and finally bear mature teleutospores early in the spring. Infected hollyhock leaves were gathered, part of which were kept out of doors and part in the culture room. Germination tests were made every month from that material. The teleutospores germinated and produced an abundance of sporidia in the middle of the winter as well as early in the spring, proving that the fungus may be carried over as hibernating teleutospores.

In the fall of 1908 badly diseased seeds of *Malva rotundifolia* were collected and kept over winter in the laboratory. Early in the spring these seeds were planted in flats in the greenhouse, where no outside infection could take place. Ten days after germination half of the seedlings showed well-developed sori on the cotyledons or on the hypocotyl. By artificial inoculation *Puccinia malavacearum* on the hollyhock is readily communicated to the *Malva rotundifolia* or *vice versa.*

Common Names for Plant Diseases: Dr. F. L. STEVENS, North Carolina Agricultural and Mechanical College.

The methods of common naming of plant diseases in America, Germany and France are discussed and the necessity of uniform usage among American plant pathologists is urged, and the appointment of a committee to draft rules for the nomenclature of plant diseases is recommended.

Malnutrition Diseases of Cabbage, Spinach and other Vegetables: Mr. L. L. HARTER, Bureau of Plant Industry. (Read by Mr. W. A. Orton.)

This disease was first observed by Mr. W. A. Orton in several of the trucking sections along the Atlantic coast, where it affects nearly all vegetables where intensive cultivation is practised. Every attempt to isolate an organism that might be responsible for the trouble resulted in failure.

The disease is characterized as follows: The plants grow poorly, have small, stubby roots with few or no laterals. The chlorophyll disappears from between the veins and around the margin of the leaf, while along the midrib and veins the color remains normal. The leaves are very much thickened and brittle. By quantitative analysis, diseased material was found to contain 77 per cent. more starch than the normal, which can be accounted for by the fact that the translocation diastase has probably been so weakened as to be unable to act upon starch.

The disease occurs only in soils containing a large amount of acids, which doubtless interfere with the normal activities of the plants and the growth of microorganisms.

The application of calcium carbonate in the soil results in the development of normal plants.

Contributions to the Life History and Structure of certain Smuts: Dr. B. F. LUTMAN, University of Vermont.

This work was suggested by the recent discoveries in the sexuality of the rusts and is an

attempt to discover whether similar phenomena occur in the smuts. It also aimed to find the relationship of the group from their finer structure.

It has been found that the mature teleutospore of all smuts is uninucleated, but that there are two nuclei in the younger one in the Tilletiaceæ and possibly so in the Ustilaginaceæ. The mycelium of the former group shows many binucleated cells, like the rusts, but in the latter group it is multinucleated. This would seem to indicate that the smuts of the *Tilletia* group are more nearly related to the rusts than those of the *Ustilago* group.

The complete life history of the oat smut (*U. levis*) was traced. It was found that the promycelial cells were uninucleated, the conidia uninucleated, but that they became multinucleated immediately after putting out a germ-tube. Infection occurred in three to five days and the entire tip of the seedling was full of the intercellular mycelium. The entire mycelium breaks up into spores at the time when the rudiments of the flowers appear.

Life History of Melanops quercuum (Schw.) Rehm forma vitis Sacc.: Dr. C. L. Shear, Bureau of Plant Industry.

The fungus under consideration has had a great variety of names applied to it in its different stages. The ascogenous stage is best known in Europe under the name *Botryosphæria Berengeriana* de Not. In America it has been frequently called *Botryosphæria fuliginosa* (M. & N.) E. & E.

Various surmises have been made as to the pycnidial form of this fungus, but all have heretofore been based upon the close association of perithecia and pycnidia on the same specimen.

Pure cultures made from carefully isolated single ascospores have produced pycnidia which at first discharged hyaline, non-septate spores of the *Macrophoma* or *Dothiorella* type. Later the spores borne in the pycnidia became brown and many of them uniseptate, corresponding exactly with *Sphæropsis viticola* Pass and *S. Peckiana* Thüm, which were also found associated with the perithecia on the specimen from which the cultures were made. They also agree in all morphological characters with *Sphæropsis malorum* Peck and *Diplodia pseudo-diplodia* Fckl. The ascogenous stage is frequently found on the apple and a great variety of other trees and shrubs and has generally been regarded by mycologists as one and the same species, though Saccardo treats some of the specimens on different hosts as forms. In a few cases another form of pycnospore was found in the same pycnidium with the *Sphæropsis* spores, the sporophores being intermingled and clearly arising side by side from the wall of the pycnidium. These spores were small, hyaline, cylindrical and $2-3 \times 1\ \mu$. These were found on the hosts and not in the cultures. The fungus is not known at present to cause any serious injury to the grape, but the form on the apple causes the well-known "black rot," leaf spot and canker.

The Chestnut Bark Disease: Dr. Haven Metcalf and Professor J. Franklin Collins, Bureau of Plant Industry.

The active parasitism of *Diaporthe parasitica* Murrill has been verified by nearly five hundred successful inoculations. Lesions may occur on any or all parts of a tree above ground, and may girdle anywhere. Most common places are crotches, base of trunk, and ultimate twigs. Roots and first-year wood are rarely, if ever, attacked. Sprouts are regularly formed below girdled points. Inoculations may take effect at any time of year, but the progress of the disease is most rapid in the spring months. A debilitated tree is no more subject to attack than a healthy one. Dry weather checks the disease by suppressing spore production. The parasite can enter without visible breaks in the bark, but wounds form the usual means of entrance. Of these the commonest are tunnels of bark borers. Winter injury is not common over the whole range of the bark disease, but may be locally important in producing lesions through which the parasite enters. Winter injury bears no other relation to the bark disease. The presence of *Diaporthe parasitica* Murrill forms a sure basis for distinguishing whether any given case is the bark disease or winter injury alone. The bark disease shows no definite relation to the points of the compass, the position of lesions being determined by the position of the wounds through which the fungus gained entrance. The present range of the bark disease is from Saratoga County, N. Y., and Suffolk County, Mass., on the north and east, to Bedford County, Va., on the south, and Greenbriar and Preston Counties, W. Va., and Westmoreland County, Pa., on the west.

Bacillus phytophthorus Appel: Dr. Erwin F. Smith, Department of Agriculture.

We owe the name and our first accurate information respecting this organism to Dr. Otto Appel, of Berlin. The following statements are the result of three years of study of this bacillus, cultures of which were received by me from Berlin

in 1906, and they are in the main only verifications or slight extensions of Dr. Appel's statements, which I have found to be very trustworthy. It is, however, I believe, the first description in English, and everything has been verified.

The organism is a non-sporiferous rod, variable in length, usually occurring singly or in pairs, but also forming chains of several individuals; taken from young agar cultures the diameter is about 0.6 to 0.8 μ, the length 1.5 to 2.5 μ; actively motile by means of peritrichiate flagella; stains readily with ordinary stains, but not by Gram's method; rots potatoes (stems and tubers), cucumbers, tomatoes, etc.; aerobe and facultative anaerobe; organism grayish white on agar and slightly bluish opalescent by transmitted light; surface colonies, on thinly sown + 15 agar, 1 mm. or less in diameter in 48 hours at 20° to 23° C., 2 to 3 mm. broad in 4 days; round, smooth, wet-shining, internally reticulated at first, amorphous under 16 mm. and 12 ocular, or with small flocks in the older portion; the buried colonies appear brownish under the microscope, also granular in the center; margin of buried colonies sharply defined; liquefaction of + 10 gelatin moderate to rapid; circular white colonies with regular margins on gelatin plates, visible in 18 hours at 30° C., in 26 hours at 21° to 23° C.; on thin-sown gelatin plates colonies grow rapidly and are frequently 2 centimeters in diameter at end of fourth day at 22° C.; alkaline reaction in gelatin cultures to which litmus has been added; on sterilized potato slow white to yellowish white growth; characteristic rapid white growth and black stain on raw potato (when streaked from agar); grows vigorously and with great rapidity on all neutral and feebly alkaline media; clouds 10 c.c. of + 15 bouillon in 6 hours at 30° C. and in 24 hours at 13° to 14° C., when inoculated with one 3-mm. loop from a bouillon culture 4 days old at 24° C.; especially good growth on neutralized potato-juice gelatin in which stab-cultures rapidly develop a funnel-shaped liquefaction, but less rapid in my hands than in + 10 peptonized beef-gelatin; gradual clouding of salted peptonized beef-bouillon, and production of chains therein and pellicle on undisturbed old cultures; no indol reaction; tolerates in beef-bouillon a considerable amount of sodium chloride (5 per cent.) and of sodium hydrate (+ 50); very active growth in potato-juice with formation of thick pellicle and heavy precipitate; rapid clouding of closed end of fermentation-tubes containing potato-juice, but no production of gas; no growth in Cohn's solution; slight greenish tinge in Fermi's solution on long standing; moderate production of hydrogen sulphide; distinct and persistent nitrite reaction in nitrate bouillon but no gas; grows in peptonized beef-bouillon from − 50 to + 16 and beyond, also in potato-broth acidulated to + 46 with citric acid, but no growth when acidulated to + 45 with oxalic acid; slow (acid) coagulation of milk with precipitation of the casein; slight reddening and final reduction of litmus in milk; slight production of gas in shake-cultures in some beef-agars; grows in bouillon over chloroform; in streak-cultures it reddens litmus agar decidedly in 48 hours at 20° C. in presence of either dextrose, saccharose, lactose, gelactose or maltose; it blues plain litmus agar decidedly in 48 hours and does not promptly redden the same with addition of dextrine or glycerine; no reddening of litmus in gelatin-cultures; the acid persists on boiling; produces small quantities of gas from innosit (muscle sugar), lactose and mannit; optimum temperature 28° to 30° C.; little growth below 4° to 5° C.; minimum temperature for growth in + 15 beef-bouillon 1° C. or under; maximum temperature for growth in + 15 beef-bouillon about 36° C.; thermal death-point in + 15 beef-bouillon 47° C.; ninety per cent. destroyed by freezing in bouillon. Appel reports loss of virulence in some of his cultures but I have not observed any during a period of three years. Undoubtedly a very large part of the potato rot of the United States is due to this organism. *Bacillus solanisaprus* Harrison is a very closely related, but not identical organism, causing a similar disease in potatoes. The same may be said of *Bacillus atrosepticus* Van Hall, cultures of which are not now available. The writer has isolated *Bacillus phytophthorus* from potatoes grown in Maine and in Virginia. The following are recommended as quick tests for differential purposes: very thin sowings on gelatin plates; streaks from agar to sterile raw potato; behavior in blue litmus milk; behavior in nitrate bouillon and in Cohn's solution. The right organism should produce big, round, white colonies promptly on thin sown gelatin plates, and should rot potato tubers promptly. It is not always easy to recover this organism from decaying potatoes, since it is quickly followed by various bacterial saprophytes —yellow and white species. The potato disease caused by this organism is known in Germany as "black leg," and by the writer as "basal stem rot."

The Central American Banana Blight: Dr. R. E. B. McKenney, Department of Agriculture (Laboratory of Plant Pathology).

In 1904 the writer made a trip through a number of farms in Costa Rica and in the Province of Bocas del Toro, Panama, for the purpose of investigating a serious banana disease reported by the planters during the two previous years. Since that time the disease has been more or less continuously studied by him.

"The disease" or "the blight," as it is commonly called by the planters, spreads rapidly. While in 1904 whole valley districts were free from the disease, there is now scarcely a single farm in the regions above mentioned that is not suffering from its ravages. The blight occurs in the Panama Canal Zone; also, by report, on the Atlantic side of Nicaragua, Honduras and Guatemala.

The disease has been known for many years, but only within the last decade has it alarmed the planters. As early as 1890 a few isolated spots were known to be affected, and from these the spread of the disease can be traced.

In Panama at least 15,000 to 20,000 acres of banana plantations have been abandoned and many thousand more are seriously affected, while in Costa Rica the damage has been even greater, so that it is safe to estimate at least $2,000,000 capital loss in these two regions in the last five years.

Young and old plantations are attacked with equal intensity. Plants are also attacked on various soils—sand, clay, etc. The disease seldom becomes evident until the shoots have reached a height of four to six feet at the collar (point where the leaves diverge). Commonly the first external sign is a rapid yellowing and subsequent browning and wilting of one or more leaves. Sometimes there is a striking curvature and yellowing of the terminal part of the leaf-blade while the remainder is still green. Eventually all the leaves die and fall back against the trunk, leaving a crop of suckers which in turn are killed and give place to still weaker shoots. The fruit of diseased shoots rarely matures and even when mature is worthless with blotched, somewhat shriveled surface and dry, pithy interior. Shoots which develop after one or two suckers have died rarely reach the flowering stage. When they do, however, weak, distorted, worthless bunches are produced.

On cutting the pseudo-stem across and longitudinally many of the bundles are found to be of of a yellow, reddish or reddish-purple color, the color deepening toward the rootstock. In the last stages the color of the bundles may be almost black. While in recently affected plants the vessels of the upper part of the stalk and the leaves may be normal, those of the rootstock are always colored. In most cases the thin partitions separating the air chambers are wrinkled and collapsed. The juice of diseased plants contains much less tannin than that of normal plants. A nauseating odor is often given off when leaf-stalks which have been diseased for some time are cut open, though there may be no sign of rotting in the trunk.

It has been proved that the disease is not due to local conditions such as too wet or too dry soil, etc., yet some of these conditions may predispose the plants to the disease.

There is a seasonal periodicity in the activity of the blight corresponding to the periodicity of growth in the banana plants. It is during the stage of most rapid growth that the plants most easily succumb, particularly from April to July. In periods of less active growth many plants seem to recover, but only to die during the next season of rapid growth.

Neither drainage nor improved methods of cultivation and pruning have checked the disease. Indeed, increased fertilization seems to make it more virulent. There is no evidence that insects are in any way responsible for the trouble.

Microscopic examination of the stained vascular bundles above mentioned shows that the coloring is due to a rather insoluble gummy substance (not a true gum) that more or less completely plugs the vessels and cells of the xylem. In this bacteria and, in some cases, fungus hyphæ, were found imbedded.

Bacterial organisms isolated in Central America from diseased material have been cultivated by the writer and inoculated into healthy plants on the plantations and in greenhouses of the Department of Agriculture in Washington. The results of this phase of the investigation will be given later. It may be stated, however, that the blight is in all probability a vegetable parasite which makes its entrance into the plant through the rhizome or roots.

No good method of control of the disease has yet been found. The progress of the disease in its early stages may be delayed by digging out and burning diseased plants, replacing them with healthy suckers.

The hope of continuing the banana industry successfully in the affected districts lies in the substitution of an immune variety. This the writer has found in a Chinese banana now occasionally grown in Central America. This sort is easily grown, yields good fruit, and has been found entirely resistant. The plantain is slightly but not seriously affected by the blight. The red banana is also subject to this blight, but less than the common yellow (Martinique) variety.

Notes on some Diseases of Trees in our National Forests: Dr. GEORGE GRANT HEDGCOCK, Bureau of Plant Industry. (Read by C. J. Humphrey.)

Notes were given on the occurrence and distribution on a large number of hosts of the following wound parasites attacking forest trees: *Polyporus dryophilus* Berk. (?), *P. obtusus* Berk., *P. sulphureus* Fr., *P. schweintzii* Fr., *Fomes igniarius* Gill., *F. applanatus* (Pers.) Gill., *F. laricis* (Jacq.) Murr., *Trametes pini* (Brot.) Fr., and *Echinodontium tinctorium* E. & E. Many new hosts for several of these species were named.

The more injurious species of mistletoe in our coniferous forests are *Razoumofskya douglasii* (Eng.) Kunze, on *Pseudotsuga taxifolia* (Poir.) Britt., *R. cryptopoda* (Eng.) Coville, on *Pinus ponderosa* Laws., *R. americana* (Nutt.) Kunze on *Pinus murrayana* "Oreg. Conn.," and *R. cyanocarpa* A. Nels. on *Pinus flexilis* James.

Of the species of *Peridermium* attacking trees in the same area, *Peridermium coloradense* (Diet.) Arth. & Kern on *Picea engelmanni* Eng., and *Peridermium elatinum* (A. & S.) Kunze on species of *Abies* are the more injurious.

Successful inoculations were made with the uredospores of *Cronartium quercuum* (Brond.) Arth. on oak leaves of a number of species for the first time, and with the teliospores of the same fungus, producing galls on the twigs of young trees of *Pinus virginiana* Mill.

Potato Wilt and Dry Rot (Fusarium oxysporium): Mr. W. A. ORTON, Bureau of Plant Industry.

This disease described by Smith and Swingle in Bulletin 55 of the Bureau of Plant Industry in 1905 is now coming into prominence as one of the most wide-spread and destructive maladies of this crop. It appears to occur throughout the United States, but is more injurious in the irrigated sections of the west and in the southern half of the potato belt.

Three types of injury occur. The most serious and least recognized is a wilting and premature ripening of the plant due to infection of the stem and underground portions. The second is a dry rot beginning at the stem, which develops most rapidly in warm temperatures. Finally, the disease is responsible for a portion of the trouble experienced from poor germination in the spring.

Of methods of control at present available rotation of crops appears most effective. Seed selection through discarding diseased portions of tubers has been proved helpful. A thin slice across the stem end affords a simple test, the vascular ring being brown where the fungus is present. There are indications that resistance can be bred, though no existing varieties are very promising in this regard.

The Double Blossom: Dr. MEL. T. COOK, Delaware Agricultural Experiment Station.

This is a disease of the genus *Rubus* originally attributed to *Fusarium rubi* Winter. It is very abundant on the Delaware-Maryland Peninsula, where it is destructive to the Lucretia and Rathbone dewberries. It is due to a fungus which appears to be a *Fusarium*. The fungus winters in the buds and the spores are formed in the open blossom. The effect of the disease is the formation of a witches broom, deformity of the blossoms and atrophy of the berries. Late blossoms are very abundant in the fields where the disease is present and also occur one year in advance of the witches brooms. These late blossoms also contain spores.

The Toxic Properties of Tannin: Dr. MEL. T. COOK, Delaware Agricultural Experiment Station.

Since the preliminary report given a year ago at the Baltimore meeting, work has been continued along the same lines and considerable additional information gained. None of the species of *Glœosporium* or *Colletotrichum* gave maximum growths on media containing more than two fifths of one per cent., and the majority gave best growths on media without tannin. *Fusarium* was much more resistant to low percentages, but none gave maximum growths above three fifths per cent. tannin.

Neocosmospora, *Cladosporium*, *Sphæropsis*, *Sclerotinia* and *Phoma* were more resistant than *Glœosporium*, but none gave maximum growths on media containing more than three fifths per cent. of tannin.

The species of *Penicillium* were retarded at first, but had a tendency to overcome the toxic action of the tannin.

The above experiments were duplicated with series of experiments in Van Tigheim cells, which gave more accurate results on germination of spores, maximum growths and formation of new spores.

A series of experiments was made to compare the growth of organisms in media in which the proteid and tannin formed a precipitate and in media in which proteid was not used.

A series of experiments was made to show relative resistance of cork from which the tannin had been extracted and cork soaked with tannin of various percentages.

Parasitism of Coryneum foliicolum and Phoma mali Schulz et Sacc.: Dr. Charles E. Lewis, Maine Agricultural Experiment Station.

Coryneum foliicolum Fckl. has been reported as common on dead spots in living leaves of the apple, but in this investigation it has been found also in cankers on the branches. The fungus has been grown in pure culture on a number of culture media and inoculations have been made on leaves, wood and fruit of the apple. In confirmation of the work of others, it is reported that this fungus does not cause leaf-spot, but in this study it has been found capable of doing great damage to young apple trees and to small branches of older trees by causing cankers which may girdle the branch, killing the parts above the girdled region.

Phoma mali Schulz et Sacc. has been isolated from leaf-spot, canker, and decaying fruit of the apple. This fungus does not cause leaf-spot, but it can attack the wood of young apple trees and branches of old trees.

Both of these fungi have been tested as to their ability to cause decay of apples. *Coryneum* causes a small amount of decay in ripe fruit. *Phoma* causes a rapid and complete decay of ripe fruit and can attack green apples to a slight extent.

Lettuce Sclerotiniose: Dr. F. L. Stevens and Mr. J. G. Hall, North Carolina College of Agriculture and Mechanic Arts.

A brief summary is presented of some of the experimental results of several years' study of lettuce sclerotiniose. The expansion of the lettuce industry and the history of this disease are mentioned. The results of a statistical study of spores from apothecia of different ages is presented, also of physiological studies concerning the temperature relations of the fungus, longevity of the mycelium under various conditions, effects of various nutrients and of alkalinity and acidity upon growth. The toxicity of various fungicides was studied, also the effects of illumination, depth of planting and stirring of the soil upon germination of sclerotia. The germination of ascospores in various media was studied, also their longevity. Special attention was given to the question of parasitism and saprophytism and to determining to what extent and under what conditions the mycelium could migrate through or over soil. The view is expressed that the ascospores and the mycelium are both short lived, that the sclerotium is the only long-lived structure and that the prevention of formation of sclerotia by the early destruction of effected plants constitutes a promising means of eradication of this disease.

Parasitism of Coniothyrium Fuckelii: Mr. P. J. O'Gara, Bureau of Plant Industry. (Read by title.)

A New Hop Mildew: Dr. J. J. Davis.

A downy mildew was observed on *Humulus lupulus* in Wisconsin in 1909 which is referred to *Pseudoperonospora celtidis* (Waite) Wilson as var. *Humuli* n. var. and a description given.

An Anthracnose of Red Clover caused by Glœosporium caulivorum Kirch.: Dr. H. R. Fulton, Pennsylvania State College.

The characteristic lesions are elongated, sunken areas on the stem, one centimeter or more long; these have dark brown borders, with lighter centers over which the acervuli are scattered. Inoculation tests indicate that infection takes place most readily through wounds, or upon succulent parts, or under very moist conditions. Under field conditions the most serious outbreaks probably occur when continued warm showery weather induces a very succulent type of growth. The conidia were found to retain their vitality in one instance for twelve months. Successful inoculations were made on *Trifolium pratense*, *T. pratense* var. *perenne* and *T. hybridium*. Unsuccessful attempts were made to inoculate *T. repens* and *Medicago sativa*. Rotation of crops, early mowing of affected fields, the use of uncontaminated seed and the planting of resistant strains of clover are suggested as control measures.

Further Studies of Phytophthora infestans: Professor L. R. Jones and Dr. B. F. Lutman, Vermont Agricultural Experiment Station.

The authors, assisted by Mr. C. R. Orton, have continued the work on *Phytophthora infestans* reported at the meeting last year. The principal advance has been made in the study of the resting bodies and in the improvement and testing out

of a laboratory method for determining disease resistance in the tubers.

In cultures of the fungus on lima bean agar and potato gelatin there were found, as reported last year, certain immature spore-like bodies. These have been found in similar cultures this year and also what appears to be a more mature stage, in the form of spiny, brown-walled resting spores apparently produced asexually. These have been found in all but three of the twelve strains now in cultivation, these three being either weak or recently isolated.

The method of testing the disease resistance of the tubers has been improved. Sterile living plugs cut from the tuber to be tested for resistance to *Phytophthora* are inoculated with the fungus and the amount of growth after nine to twelve days is compared with that on plugs cut from tubers known to be resistant or susceptible. In this manner over eighty varieties of potatoes have been tested and rated on a percentage basis as to their tuber resistance. The ratings were found to agree very closely with the relative tuber resistance, as shown by the field experiments conducted by Professor William Stuart. The probable advantage of the laboratory over the field method is obvious both in saving of time and in precision of results.

Some Studies on the Bean Anthracnose: Dr. C. W. EDGERTON, Louisiana State Experiment Station.

This includes the results of two years' study on the bean anthracnose under Louisiana conditions, including the period of incubation, methods of surviving the winter, relation of the fungus to temperature and various soil microorganisms, and the relation of the fungus to other anthracnoses.

Under the best conditions for growth of the fungus, the period of incubation is from four and a half to six days.

The fungus survives the winter by means of mycelium in the seed and by spores. On the diseased seed there are found some spores, at least as late as February, that are viable, and spores that are between the cotyledons in the seed, and so protected, are nearly all viable at this time. Spores are formed on the surface of the seed, between the cotyledons in the seed, or in closed pycnidial-like cavities in the tissue of the seed.

The fungus is not able to live in the summer months in Louisiana on account of the high temperature. In cultures in the laboratory with special care the fungus can be kept alive, though it makes a very feeble growth; but in the field the disease is killed out entirely. When a mean temperature of about 80° F. is reached with the minimum above 70°, growth seems to be prohibited.

Various organisms in the soil, especially a species of *Fusarium*, destroy much of the anthacnose in the seed. This is accomplished by rotting the seed, or by merely crowding out the anthracnose in the spot itself. A large per cent. of the spots on the cotyledons of young bean seedlings, that grow from spotted seed in Louisiana, contain *Fusarium* and no anthracnose.

Inoculations with spores of the bean anthracnose, have given abundant infection on bush beans, slight infection on pole beans, slight infection on Lima beans, and no infection on peas, young cucumber plants, cucumber fruits, alfalfa and cotton plants. Inoculations on growing bean plants or young pods with anthracnose spores obtained from fig, cotton, rose and pepper gave no infection, while check inoculations using spores obtained from the bean gave abundant infection. However, the treatment of healthy bean seed just before planting with suspensions of spores obtained from the cotton, fig and rose plants, resulted in many cases either in the rotting of the seed by the anthracnose or the spotting of the young cotyledons. These spots, however, though they contained anthracnose spores, did not look like bean anthracnose spots, nor did they develop further after the cotyledons were pushed above the ground.

Venturia inequalis, Ascospore Dissemination and Infection: Mr. ERRET WALLACE, Cornell University.

The life history of *Venturia inequalis* (Cooke) Wint. is in general well known to pathologists. The conidial stage grows parasitically on the leaves and fruit of the apple, causing the disease commonly known as "scab" or the "fungus." The perfect stage develops saprophytically on the fallen leaves during the winter, maturing its ascospores the following spring.

During the spring of 1908 and a portion of the winter of 1909, the writer gave some attention to a study of a few details of some phenomena connected with the perfect stage of this fungus.

In the spring of 1908 the method of ascospore discharge was quite carefully studied. Two types were observed, the one commonly known, by extrusion of the asci through the ostiole of the perithecium and another in which a circumcisal dehiscence takes place, the upper half or more of

the perithecium being burst off, exposing all the asci at one time.

The former is doubtless the natural method, but in many cases the number of asci preparing for action at one time may be greater than can be accommodated by the ostiole, and the expansive force bursts off the upper part of the perithecium.

By placing glue-coated slides at various heights over moistened leaves, some data were obtained as to the height to which ascospores may be discharged. This was not found to exceed 1.5 cm., and very few reached this height. In a similar manner it was determined that from a portion of leaf 1 cm. square 5,630 spores were discharged in 45 minutes. In an orchard set 40 feet each way, the surface of which was covered with fallen leaves, if no limiting factors were considered, there might be at this rate 8,107,200,000 ascospores to each tree discharged in a period of 45 minutes of wet weather.

During the winter of 1909, leaves examined at different dates showed that, by February 26, the perithecia had formed, in the asci of which was as yet no evidence of spore formation. Even at this stage, when pricked out in water on a slide, dehiscence of the perithecia would sometimes occur, without extrusion of the asci.

By March 20 immature hyaline spores had formed. On leaves kept in moist chambers in the laboratory since February 27, they were much more advanced, some spores being sufficiently mature to be discharged.

Infection of leaves was repeatedly induced by inoculation with ascospores. The method of infection was studied and camera lucida drawings showing the germ tube piercing the cuticle were obtained. The period of incubation varied from eight to fifteen days.

It seems probable that ascospore infection is, in most cases, largely responsible for early attacks of scab on leaves and petioles. The writer was called to diagnose a case in western New York, in which this fact was strongly evident. With one exception every orchard in the immediate vicinity had a very severe attack of early leaf infection. On talking with the owners, it was learned that the above exception was the only case in which the fallen leaves had been plowed under the fall before. An examination of those leaves remaining showed an abundance of perithecia.

Polystictus hirsutus as a Wound Parasite on Mountain Ash: Dr. Jas. B. Pollock, University of Michigan.

At Ann Arbor, Mich., two mountain ash trees were for several years under observation, each tree having one of its main branches partly dead, and in each case the dead branch was covered in part by sporophores of *Polystictus hirsutus* Fr. The diseased condition was progressive in both trees for several years, the trees gradually dying off, and both trees were removed before they were completely dead. Observations were made on one of them when it was dug up, and the decay of the wood had extended from the dead branch into the main trunk, to a point below the surface of the soil in which the tree stood. This decayed heart wood was filled with a white mycelium. Pieces of this wood were placed in moist chambers, and after a month or two fruiting bodies developed which showed it to be the same fungus whose fruiting bodies developed for several successive years on the dead branch fifteen feet above.

The observations seem to show that this fungus not only is a wound parasite, destroying the dead heart of a tree, but that it slowly and progressively attacks the cambium, gradually killing off this species of tree.

Notes on Plant Diseases in Cuba: Professor William Titus Horne, California Agricultural Experiment Station. (Read by C. L. Shear.)

A list of publications on plant pathology arising from the writer's work at the Cuban Experiment Station is given, and the following diseases of the principal cultivated plants are discussed: sugar-cane troubles—drouth, exhausted soil, moth borer and root fungus; tobacco—damping off, leaf spot and root disease; banana—an undetermined disease; mango and aguacate: mango—blossom and tip blight (*Glœsporium*), aguacate—destructive disease not determined. Also diseases of citrus fruits and vegetables.

Failures due to lack of adaptation or unappropriate periodicity are also mentioned and education and improved agricultural practise suggested as necessary to utilize the results of the plant pathological investigations which have been made.

Two Diseases of Cosmos: Mr. F. C. Stewart, New York Agricultural Experiment Station. (Read by title.)

A Cuban Banana Disease: Dr. Erwin F. Smith, Department of Agriculture.

My attention was first called to this disease in December, 1908, by Mr. Horne, of the Cuban Experiment Station, who requested me to study the cause of the disease. Up to this time I have been unable to visit western Cuba where it pre-

vails, especially in bananas used as shade for tobacco, but I have received several lots of diseased material, and now have affected plants growing in one of the Washington hothouses.

The signs of the disease so far as I have been able to obtain them from Cubans, and as the result of my own examinations, correspond quite closely to those described by Dr. McKenney, and also to the banana disease described by Mr. Earle from Jamaica in 1903. A similar, if not identical, disease prevails in Trinidad, according to statements made to me by Mr. James Birch Rorer, from whom I have also received alcoholic material. A similar disease occurs in Dutch Guiana, according to statements recently received by me from Dr. van Hall, director of the experiment station in Suriname. I am inclined to think that the Central American disease is also the same as this disease, although we are not yet certain, Dr. McKenney and myself having joined forces to settle, if possible, the problems relating to banana diseases in these regions. Possibly there are two banana diseases now confused—one due to bacteria, the other to fungi.

A microscopic examination of the Cuban material showed bacteria to be present in some of the vessels, but not in quantity sufficient to lead me to suppose them to be the cause of the disease. In passing, I might say that Earle sent me cultures of the bacteria isolated by him from the diseased Jamaican bananas and that in the summer of 1904 I inoculated these copiously into the leaf-blades and petioles of bananas in Washington, but without production of any disease. In the Cuban plants no fungi were observed at first, but further studies revealed a small amount of mycelium running in the vessel walls or their vicinity, but in no case plugging the lumen of the vessels. No spores were observed at first, but after awhile I thought I made out, although rather indistinctly, one or two microconidia, and jumped to the conclusion that the fungus was a *Fusarium*. Poured-plates were then made from the interior of affected leaf-stalks which were sound on the surface and a *Fusarium* was obtained on the plates in practically pure culture, the colonies having evidently been derived from microconidia present in the bundles. Transfers were made from these colonies and after a half-year or more, rapidly growing, large banana trees were inoculated from subcultures. The inoculations were made by means of punctures into the midrib, leaf-stalk and pseudo-trunk. At this time the bananas were about twenty feet high, perfectly healthy and with trunks a foot in diameter. As a result of these inoculations the writer obtained infection of the vascular bundles of the petiole of several leaves to a distance of from five to eight feet and more from the point of inoculation. The bundles became brown-purple in the typical manner and the *Fusarium* with microconidia was demonstrated in the interior of these bundles by microscopic examination, especially after treatment with 10 per cent. potash (drawing exhibited), and was also isolated from the same at this distance from the point of inoculation by means of Petri-dish poured-plates, the exterior of these petioles being at the time perfectly sound. It has thus been demonstrated beyond dispute that the affected Cuban plants contain a *Fusarium* which is able to run long distances inside of the vascular bundles and cause a purple, purple-brown or blackish stain of the same. What has not yet been demonstrated is that such inoculations will so disease the rootstock that other uninoculated leaves will subsequently show the typical signs of the disease. I was obliged to break off this experiment after about two months, owing to the necessity of moving the hothouse, and building another one before experiments could be continued. The rootstocks from which the inoculated infected leaves were cut away have, however, been planted out in the new house, and additional inoculations have been made, the results of which ought to be positive one way or the other in the course of the coming year.

The fungus may be designated for the present as *Fusarium Cubense*. It produces macroconidia and microconidia of typical form, reddens and purples various culture media, and has not so far shown any ascospore form. The chief characteristic separating it from other species so far as yet known is its location in the diseased banana plant and its ability to produce the before-mentioned disorganization phenomena in the vascular bundles, but no doubt other peculiarities will be developed as the study of the organism progresses.

A very considerable part of the banana holdings in tropical America are in the hands of Americans, and as we also consume the greater part of the product, it is highly important to prevent such destruction of the plantations as shall lead to a loss of American capital and an increase in the price of this important food product.

The Blackleg Disease of the Potato in America: Professor W. J. MORSE, Maine Agricultural Experiment Station. (Read by title.)

Studies on the Club Root of Cabbage: Dr. HOWARD S. REED, Virginia Agricultural Experiment Station. (Read by title.)

The Curly Top Disease of Sugar Beets: Mr. HARRY B. SHAW, Bureau of Plant Industry. (Read by Mr. W. A. Orton.)

The various names by which the disease is known are briefly referred to, then follows a description of the symptoms observed to be characteristic of it. The fact that the resisting power of the beet varies according to the size of the latter is referred to.

The most important theories as to the cause of curly top are mentioned, together with a review of the writer's experiments covering many of the theories set forth.

Certain experiments with leaf hoppers commonly found on the beet, and the fact that the leaf hopper, *Eutettix tenella* Baker, is the primary cause of curly top in beets, is recited.

Observations were made to the effect that curly top disease may develop in beets planted for seed production the second season although no symptoms of the disease were visible when those beets were harvested the preceding fall. This was demonstrated to be the case, and experiments establishing this fact are described. This renders the disease a double menace to the production of beet seed.

Four Years' Results in Selection for a Disease-resistant Clover: Professor S. M. BAIN and Mr. S. H. ESSARY, Tennessee College of Agriculture and Experiment Station.

The announcement was made by the authors in 1906 of the marked resistance shown by the progeny of select clover plants to the *Colletotrichum* disease occurring in Tennessee. This resistance has been maintained under various cultural and laboratory conditions for five successive generations, and there no longer exists any doubt as to the economic value of the strain being propagated. There will be about fifty acres grown in the seed crop during the season of 1910.

The indications are that a naturalized strain was found in the original selections. The resistance shown to the anthracnose is probably due to acclimatization, and is, therefore, not specific. An outbreak of rust in 1908 brought out indications of rust resistance also.

A Fungus Enemy of Mushroom Growing: Mrs. FLORA W. PATTERSON, Bureau of Plant Industry.

The paper relates to the first occurrence of *Mycogone perniciosa* Magnus in American mushroom beds. The fungus was identified by the author in several collections received from mushroom beds in Pennsylvania during March, 1909. The disease caused by this fungus has long been recognized as a serious one by growers in England and on the continent. The parasite is variously referred to by writers as *Mycogone perniciosa* Magnus and *Hypomyces perniciosus* Magnus. The latter name was previously given it by Magnus in 1887, who, however, did not describe the perfect stage, but reasoning from analogy, inferred it would be found in the genus *Hypomyces*. Two conidial stages, a *Verticillium* sp. and *Mycogone perniciosa*, have been identified in the American material, and it is hoped that the perfect stage may develop in cultures that are being kept under observation.

European Currant Rust on White Pine in America: Dr. PERLEY SPAULDING, Bureau of Plant Industry.

The European currant rust has two stages: one as *Peridium strobi* on the white pine, the other as *Cronartium ribicola* upon leaves of *Ribes*. The fungus is native in eastern Europe upon *Pinus cembra*, upon which it usually does little damage. Since about 1860 it has attacked *Pinus strobus*, *P. monticola* and *P. lambertiana*, all American species of five-leaved pines. At present it is distributed throughout Europe, and is causing great damage to white pines in certain sections. In the spring of 1909 it was imported into the United States upon about two and a half million young white pine trees, being distributed in the states of New York, Vermont, New Hampshire, Massachusetts, Connecticut and Pennsylvania. Lots of trees from the same nursery are also known to have been imported into Ontario and Minnesota. During the past summer a special effort was made to remove the *Ribes* from the vicinity of these plantations, and, it is believed, successfully, except in portions of Connecticut and in Ontario and Minnesota, which latter are to be inspected by local authorities. This work was carried on in cooperation with the forestry and plant pathological workers of the states involved. The National Department of Agriculture has absolutely no power to prohibit importing, or to inspect, condemn or destroy such imported stock, except by courtesy of the owner. The situation is especially serious should the importation continue in future years upon the same scale as during the last year. Immediate action should be taken by the various states in-

volved, either stopping such importation or providing such inspection and quarantine laws as are best adapted to the situation.

C. L. SHEAR,
Secretary-Treasurer

(*To be continued*)

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 679th meeting was held on April 9, 1910, Vice-president Fischer in the chair. Two papers were read.

Times of Abruptly Beginning Magnetic Disturbances as Recorded at the Coast and Geodetic Magnetic Observatories: R. L. FARIS, of the Coast and Geodetic Survey.

The speaker gave a brief review of the researches that had heretofore been made by investigators concerning the sudden beginnings of magnetic storms, with special reference to their times of beginning at different places, the general impression hitherto being that they are simultaneous, or so nearly so, all over the earth that the time scales of the records were too small to warrant any other conclusion. Dr. L. A. Bauer having recently found that there is a definite time element in the propagation of the magnetic disturbance in some special cases investigated by him, the speaker, at his suggestion examined a number of cases of suddenly beginning magnetic disturbances recorded at the Coast and Geodetic Survey magnetic observatories, which cover a quarter of the globe in longitude, with the result that the investigation showed that there is a persistent time difference for the storm beginnings at different places which is too large to be attributed to errors in the time determinations, thus confirming the results of Dr. Bauer's recent investigations.

The paper will appear in full in the June, 1910, number of the *Journal of Terrestrial Magnetism and Atmospheric Electricity*.

On the Analysis and the Propagation of Magnetic Disturbances: Dr. L. A. BAUER, of the Carnegie Institution of Washington.

An examination of the times of beginning of the magnetic disturbance which occurred on May 8, 1902, as coincidently with the Mont Pelé eruption as can be determined, revealed the interesting fact that they were not the same all over the globe, being, in general, earliest at European stations. The times next progressed going around the earth eastwardly, the complete circuit being made by the disturbance in about three and one half minutes. This fact led to an examination of other similar disturbances, such as the one of January 26, 1903, and it was again seen that this one also progressed around the earth eastwardly, the time for the complete circuit being about four minutes.

Mathematical analyses were next made and it was found that for both disturbances (May 8, 1902, and January 26, 1903) the systems of disturbance forces which it would be necessary to superpose upon the earth's own magnetic field, were precisely of the same character as the earth's. In other words, were we to assume electric currents as forming the disturbance systems, then, as is the case for the earth's field, the currents would have to circulate around the earth from east to west if they are positive ones, and in the contrary direction—from west to east—if they are negative, or such as would be produced by moving negative charges. Furthermore, for both disturbances the electric currents would have to circulate chiefly in the regions above the earth.

For the disturbance of May 8, 1902, there were a sufficient number of reliable determinations of the effect on the vertical intensity and accordingly it was possible, by means of the analysis, to separate the external system of currents from the internal (below the surface) one. And then the surprising result revealed itself, that the internal currents went in the same direction as the external ones, the latter being of about three times the strength of the former. Hence, were we to suppose that the disturbance is caused by the motion of negative charges around the earth eastwardly, then the internal negative currents also go in the same direction and, accordingly, they are not currents induced in the earth by the outer system.

If the earth's own magnetic field is likewise separated into an internal system and an external one, it is also found that for both systems the negative currents go in the same direction around the earth, viz., from west to east. The disturbance systems found above are therefore precisely similar in character to the earth's field. It should also be noted that the direction of the disturbance negative currents progress around the earth in the same way as did the times of beginning referred to above. The assumption is therefore a natural one that such disturbances as here investigated, which Birkeland in his recent important work[1] called "equatorial perturbations,"

[1] Birkeland, Kr., "The Norwegian Aurora Po-

might be due to the passage of negative charges around the earth.

Cathode rays coming from the sun and entering the earth's magnetic field at right angles as they would do for the magnetic equatorial regions, would be deflected and be made to pass around the earth in the form of a ring composed of negatively charged particles (corpuscles). Birkeland looks to such a ring as the cause of the said "equatorial perturbations." However, unfortunately the deflection of the solar cathode rays is not in the right direction, for they would be made to pass around the earth from east to west and not from west to east as required by the results of the analyses stated above. On the other hand, cathode rays coming from the earth would be deflected so as to pass around the earth from west to east, thus fulfilling one condition. But, if the radius is computed of the ring of moving corpuscles, it is found that the orbit of the latter would have to be distant from the earth's center 580 times the earth's radius or 3,700,000 kilometers or 2,300,000 miles, and thus the possibility of a terrestrial origin of the cathode rays is likewise eliminated. Furthermore, if we calculate the intensity of the current which at that distance could produce the observed effects of the disturbances of May 8, 1902, and January 26, 1903, it is found to be 5,900,000 amperes. Now Birkeland says on page 311 of his book:[2] "In the case of the greater storms, we found current-strengths that varied between 500,000 and 1,000,000 amperes, or even considerably more." Hence, to produce the comparatively insignificant magnetic disturbance effects here considered, by supposing a band of cathode particles circulating around the earth, would require a current at least six times stronger than that which Birkeland finds sufficient to account for the much larger storm effects!

The hypothesis was next briefly examined on which the disturbance effects considered might be referred to alterations in the electrical conductivity of the atmosphere and of the earth either brought about by the secondary effects from bombarding cathode particles, viz., the formation of Röntgen rays or say by the entrance into the earth's field of penetrating radiation (γ rays of radium). The ionizing effect and resultant alteration of electrical conductivity of the regions involved might either be due to the penetrating radiation from the sun or from the earth, if only *qualitative* results are considered. It is therefore at present not possible to state definitely whether the initial cause of the disturbance of May 8, 1902, was due to a terrestrial eruption or a solar one. First, further examinations will have to be made of the disturbances of May 20 and July 9, 1902, which were again closely coincident with Mont Pelé eruptions. The electric-conduction hypothesis appears to satisfy in general the observed phenomena and accordingly it is to be subjected to a further rigid examination. It seems also to explain why some of the disturbances take a westward path although the majority of them go eastward.

laris Expedition 1902–1903," Vol. I., "On the Cause of Magnetic Storms and the Origin of Terrestrial Magnetism," First Section, Christiania, 1909.

[2] "The Norwegian Aurora Polaris Expedition, 1902–1903," Vol. I., "On the Cause of Magnetic Storms and the Origin of Terrestrial Magnetism," First Section, Christiania, 1900.

(The abstracts of the above papers are by their authors.)

R. L. FARIS,
Secretary

THE GEOLOGICAL SOCIETY OF WASHINGTON

AT the 230th meeting of the society, held in the George Washington University, Wednesday evening, March 23, 1910, Mr. F. L. Hess presented an informal communication on "Mounds Formed by Crystallization." In a playa known as Salt Lake in the Mohave Desert, at Cane Springs, twenty miles west of Randsburg, California, mounds from 2 to 4 feet high and from 50 to 200 feet broad are formed in the moist lake bed through the crystallization of salts, mostly mirabilite with some epsomite. A few mounds are apparently formed through the crystallization of common salt. About six inches of earth forms the surface of the mounds, below which there is a spongy mass of the salts. Mr. E. S. Bastin spoke informally on the origin of the graphite at Lead Hill near Ticonderoga, N. Y. The graphite probably represents the original carbonaceous constituent of sediments which have been altered first by dynamic and then by igneous metamorphism due to the intrusion of granite pegmatite. A study of the quartz of the contact zone following the methods of Wright and Larsen shows that it crystallized below 575° C. This is the first test which has been made on contact-metamorphic quartz and gives a key also to the temperature of formation of the graphite, augite, scapolite, calcite, titanite, pyrrhotite and vesuvi-

anite with which the quartz is intimately intergrown. The contrast between the low temperature here indicated and the temperature at which graphite is produced in the electric furnace (certainly over 2000° C.) emphasizes the importance of the presence of other substances and possibly of the time element in crystallization under natural conditions. Mr. T. Wayland Vaughan announced the existence of two Miocene horizons at Porter's Landing, Ga., the upper one of which is definitely correlated with the Duplin Marl of North Carolina and the lower one of which is the approximate equivalent of the Calvert formation of Maryland.

Regular Program

Weathering of Coal in the Arid Region of the Green River Basin, Sweetwater County, Wyoming: ALFRED R. SCHULTZ.

Coal beds in arid as well as in moist climates show considerable deterioration along the outcrop and this deterioration in many places extends to the base of the belt of weathering or well down into it. The belt of weathering, from a geologist's point of view, is the surficial belt extending from the surface of the earth to the level of ground water. In this belt all the important reactions characteristic of the zone of katamorphism, namely, oxidation, carbonation, hydration and solution, exert their maximum activity. The zone of katamorphism is the zone in which alterations of rocks result in the production of simple compounds from more complex ones. This zone extends from the surface of the earth to a depth of 10,000 meters and is divisible into two belts: (1) an upper belt of weathering and (2) a lower belt of cementation, the two being delimited by the level of ground water. As the ground-water level in arid regions lies at considerably greater depths below the surface than in well-watered regions, it is but natural to suppose that the belt of weathering extends to proportionately greater depths in dry than in moist climates. It would then follow that the deterioration of coal should extend farther below the surface in arid regions than in regions where the top of the water table lies only a few feet below the surface of the ground. That the deterioration of the coal does not always extend to the bottom of the belt of weathering as above defined or even to a considerable depth into this belt is a fact not well known. In order to ascertain to what extent and depth the coal beds in the arid regions have been altered a total of 85 samples were collected and analyzed from the coal beds in the Rock Springs field. Of these 45 were collected from coal beds in the Rock Springs group, 20 from coal beds in the Almond group, 10 from coal beds in the Black Buttes group, and 10 from coal beds in the Black Rock group. The first two are of Montana age, the third "Laramie," and the fourth Tertiary.

Considered with regard to physical as well as chemical properties the coals occurring in these four groups fall into two classes, bituminous and subbituminous. The bituminous class includes all the high-grade coal of the Rock Springs group; the subbituminous class all the coal of the Almond, Black Buttes and Black Rock groups. The difference between these two classes is physical as well as chemical. The Rock Springs coal usually has a lower percentage of water, remains firm and compact on exposure to air, and stands shipping well without breaking down. The coals from the three overlying groups, although from different horizons and of different ages, have essentially the same physical properties and bear a regional resemblance to one another. On exposure to the sun and open air they alter very rapidly, lose their bright luster, air slack and break down into irregular blocks or powder. Cracks usually form along the bedding planes and somewhat irregularly in other directions. The coal does not stand shipping without breaking down or slacking, unless it is kept from the sun and circulating air while in transit. It is probable that the Rock Springs coal has undergone a more complete devolatilization, deoxygenation and concentration and does not assimilate oxygen so rapidly on exposure to the air as the other coals. The hydrocarbon compounds represented by the Rock Springs coal appear to be much more stable under atmospheric conditions than those represented by the higher coals. It is clearly evident that along the outcrop of a coal bed and down the dip at least three zones may be recognized—those of surface weathering, under-ground weathering and unaltered coal.

The results obtained in the Rock Springs field indicate that so far as coal decomposition or deterioration is concerned the belt of weathering in arid regions may be divided into two members. Coal in the lower member of the belt apparently shows no greater effect of weathering than the coal below the level of ground water, but coal in the upper member, or in the surficial belt of weathering, shows remarkable deterioration and decomposition. The protection of the coal above the level of ground water in the lower member of the belt of weathering may in part be accounted

for by the accompanying beds of clay and shale, which tend to shut out the oxygen and free circulation almost as readily as the ground water.

The analyses show that the proportions of the various constituents are about the same whether the sample of coal was taken near the surface or at a greater depth, the only exception being in the oxygen, which in every case is perceptibly higher near the surface than at greater depths and by its excess shows the extent of the surficial belt of weathering. The ash, sulphur and hydrogen content remain fairly constant. There appears to be a slight increase in the amount of hydrogen and ash in the samples obtained near the surface, with a corresponding decrease in the amount of sulphur. It appears from this that the belt of surficial weathering is one of marked oxidation and in this field for the most part lies near the surface, in few places, if anywhere, extending to the ground-water level. If the coal is not open or exposed to the air the weathered zone does not, as a rule, extend more than 150 feet down the dip of the beds, or 50 feet below the surface. Along slopes and mine or prospect entries the coal weathers back several hundred feet from the mouth of the mine and several hundred feet below the surface. It is known that in one old mine the coal has changed at least 20 feet back from the face of an old entry approximately 227 feet down in the mine and that deterioration extends back into the mine 575 feet from its mouth. It is very probable that in an abandoned mine remaining open to the air oxygenation in time extends throughout the mine and that the coals of lower grade show the effect of oxygenation much more than the high-grade coals.

Evidences of Paleobotany as to Geological Climate: DAVID WHITE and F. H. KNOWLTON.

On the climatological criteria offered by the fossil floras, their characters, distribution and changes, the authors base the following tentative conclusions as to general conditions and principles:

1. Relative uniformity, mildness (probably subtropical in degree) and comparative equability of climate, accompanied by a high humidity, have prevailed over the greater part of the earth, extending to, or into, the polar circles, during the greater part of geologic time since, at latest, the Middle Paleozoic. This is the regular, the ordinary, the normal condition. From a broad point of view these conditions are relatively stable.

2. The development of strongly marked climatic zones, at least between the polar circles, is exceptional and abnormal. It is usually confined to short intervals, or to intermittently oscillating short intervals, all within relatively short periods.

3. The periods of abnormal climatic differentiation are characterized by the development of extremes—*i. e.*, by extreme and abnormal heat or cold (glaciation), humidity or aridity—which are local or regional in their occurrence and variable or unstable.

4. The brief geological period in which we live is a part of one of the most strongly developed and unstable of these abnormal intervals of radical change. The assumption that climatic variations, contrasting extremes and complexity of combination and geographic distribution of climatic factors, such as now exist, are normal or essential, and that they were present also, though in slightly less degree, in all geological periods appears to be without paleobotanical warrant. The proposition that we are still in the glacial epoch is paleontologically true. We have no evidence that in any other post-Silurian period, with perhaps the exception of the Permo-Carboniferous glacial period, have the climatic distribution and segregation of life been so highly differentiated and complicated as in post-Tertiary time.

5. The distribution and characters of most of the great pre-Tertiary floras show that time and again during the great periods of relative uniformity and equable mildness, plant associations were able to pass from one high latitude to the opposite without meeting an efficient climatic obstruction in the equatorial region. The unchanged features of the species and the grouping of the latter show that the climatic elements of the environment must have been similar throughout the range of the flora. Therefore it appears that a climate essentially the same must have continued from one latitude to the other without the interposition at those periods of a torrid equatorial zone. The absence of the latter may also be inferred from the relative uniformity of distribution in other directions, as shown by the remarkable east-west and radial ranges of the floras.

6. The development and existence of torridity—*i. e.*, of a torrid zone in the equatorial belt or any other great region of the earth—is concomitant and causally connected with the development of regional frost. It would appear that the occurrence of a torrid zone is peculiar to abnormal or glacial intervals.

EDSON S. BASTIN,
Secretary

SCIENCE

Friday, May 20, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

THE GROUP AS A STIMULUS TO MENTAL ACTIVITY[1]

The purpose of this paper is not to present the results of an original investigation, but merely to suggest a problem. Efficiency in brain activity and in correlated mental activity depends upon many conditions. Among these are physiological age, race, sex, the blood supply to the brain, as determined by general nutrition, exercise, posture, and the size of the cerebral arteries; the quality of the blood as determined by food, drugs, the supply of oxygen, nasal respiration, etc.; again by a group of conditions which make up the environment, the temperature, humidity, barometric pressure, light, peripheral stimulation, etc. Again as the social instincts in man are fundamental, one of the most important factors in his environment is the presence or absence of other human beings. This can not be ignored. The problem I wish to present is this: What is the effect on mental activity of the presence of a group of other persons, if studied objectively like the effects of temperature, barometric pressure, or the like? Perhaps the best way to present this problem is to recount briefly the meager but important results of investigations already made.[2]

Studies in social psychology have shown that an individual alone and the same individual in a group are two different psychological beings. Recent investigations show that the same is true of children. The

[1] Read before Section L, American Association for the Advancement of Science, Boston, December, 1909.

[2] For reference to the studies mentioned below see *Ped. Sem.*, Vol. XII., June, 1905, pp. 229–230.

child working alone is different from the child working in a class. A few years ago Dr. Mayer, of Würzburg, studied experimentally this difference as regards the ability to do school work. His problem was to determine whether and under what conditions the work of pupils in a group give better results than the individual work of the isolated pupil. He tested the ability of pupils to work alone or in company with others, using dictation, mental arithmetic, memory tests, combination tests after the manner of Ebbinghaus, and written arithmetic.

Dr. Mayer's method was briefly as follows: a number of boys in the fifth school year of the people's school in Würzburg were given five different tasks as class exercises, and also each boy was required to prepare a similar task for comparison in which he sat alone in the class-room, only the class teacher or a colleague being present. The material for the tasks was carefully chosen and was familiar to the pupils. The pupils were representative of very different elements as regards school ability, behavior, temperament, and home conditions. The number tested was 28, the average age twelve years.

In general the result of the work of the pupils in groups was superior to their work as individuals. This appeared not only in the decrease of time, but in the superior quality of the work done. In individual cases the saving of time was specially striking; for example, one pupil for a combination test required 10 minutes and 25 seconds when working alone, for a similar test when working with the group 7 minutes and 30 seconds; another, alone 13 minutes and 11 seconds, with the group 6 minutes and 45 seconds.

Dr. Triplett tested the influence of the presence of a coworker on a simple physical performance. His subjects were forty school children, and he had them turn a reel as rapidly as possible. The children turned the reel now alone and then in company with another child, in both cases with directions to turn as rapidly as possible. Two results were noted. It appeared, on the one hand, that pupils worked more rapidly when another child worked in combination; but, on the other hand, in case of many children, hasty uncoordinated movements appeared which reduced their performance.

Wherever men are together the individual is influenced by others without being aware of it. This is specially well illustrated by certain experiments in the laboratory. Meumann cites the case of a subject whose work at night with the ergograph had a very definite value. Accidentally one evening Meumann entered the laboratory, and at once the work done was decidedly increased in comparison with that of other days, and this without the subject's making any voluntary effort to accomplish more. In such experiments the subject always attempts to do his utmost, and hence the significance of the increased work done in the presence of another individual. Many examples of such effects of suggestion have been reported by psychologists.

Meumann, in experiments in the People's Schools, corroborated the results of Triplett and Féré in a striking manner. Seven pupils of the age of thirteen or fourteen were tested repeatedly with the dynamometer and ergograph. In case of the test of the pupils separately, with no one else in the room, the amount of work was always less than when others were present. If the experiments were made in the presence of the teacher alone, the pupils did not do as much work as when they were all together without the teacher.

From all this it appears, as Mayer points

out, that pupils in a class are in a sort of mental *rapport;* they hear, see and know continually what the others are doing, and thus real class work is not a mere case of individuals working together and their performance the summation of the work of many individuals; but there is a sort of class spirit, so that in the full sense of the word one can speak of a group performance, which may be compared with an individual performance. The pupils are members of a community of workers. The individual working by himself is a different person. Schmidt in his careful investigation testing school children in their home work as compared with their school work found that for most kinds of work the product in the class-room was superior. His results are to a considerable degree evidence in corroboration of the results found by Mayer. The child studying school tasks at home is relatively isolated; in the class he is one of a social group with common aims.

A noteworthy result of these investigations is the apparent immunity of children to distraction from ordinary causes. Schmidt found that the outside disturbances—the noise from the street, from adjoining rooms, and the like, had little effect upon them. It was only interruptions that distracted their attention, such as conversation with others, that affected the quality of their work. It appeared even that a home task completed without disturbance might be poorer than the corresponding class work, and that a home task when the pupil was disturbed might be better than the class work. And from Mayer's study it appeared that the tendency to distraction is diminished rather than increased by class work.

Meumann in tests of the memory of pupils alone and when working together found similar results. Disconnected words of two syllables were used, which were written down, pronounced once to the pupils and then written down immediately by them from memory. It would naturally be supposed that the children working in the class-room, with all the inevitable noises and disturbances, would not remember as well as when tested alone. The result of Meumann's investigation, however, was surprising. While in case of children thirteen and fourteen years of age there was no essential difference in memory for the individual and the common test, the difference was remarkably large in case of the younger children, especially in case of those eight and nine years of age. On an average with the individual test the children remembered considerably less than in the class. The results were constant. Not a child was found who remembered more in the individual test than in the class test. From this Meumann concludes that the great number of disturbing influences to which children are inevitably exposed in the classroom—the noise of writing, whispering, walking about, the occasional words of the teacher, the sight of the movements of the pupils, and the like, which one might naturally suppose would make the results inferior, have no special influence.

Meumann asked a number of the pupils in case of the individual tests whether they would prefer to take such exercise in the class or alone, whether they were disturbed by the noise of the other pupils. To his surprise 80 per cent. of the pupils gave the decided answer that they would prefer to do the work in the class. Some 15 per cent. gave no definite answer. The others, an extremely small minority, replied that they were disturbed in the class-room; and in most cases these were sensitive, nervous or weak children, although among them were some individuals of decided talent.

Thus it appears that the presence of a

group distinctly affects the mental activity. Of course the easy explanation of the increased ability to work often found in the group is to say that it is due to ambition, rivalry and the like. This is all true enough, but we can analyze this a little further.

A few things are pretty obvious. First of all, where activity is involved, there is the stimulus to greater exertion which comes from the sight of another performing an act. As Professor James has said, the sight of action in another is the greatest stimulus to action by ourselves. This has manifold illustrations from the activities of primitive man to modern experiments in the laboratory. In early stages, for example, an institution sometimes found is the *præsul*. A leader stands before a group who are engaged in work or a dance and himself performs perhaps in pantomine the activities which they are attempting. This stimulates and renders easier the activity of the group. Every paced race on the athletic field also furnishes an excellent illustration. Again in the laboratory, Féré found that the amount of work one could do with the ergograph was increased by having another person simply go through the action of contracting the muscles of the finger in sight of the subject of the experiment, the second person acting as a sort of pace-maker for the first. The clearer and more intense the idea of an action the more efficient the action.

There is undoubtedly also an affective stimulus in the presence of the group. This is the stimulus which comes from our social impulses as inherited from the past, and yet it should be noticed that such affective stimuli, which, I take it, are what is really meant by ambition and the like, may act either to increase or to inhibit the mental activity. A certain degree of affective stimulus undoubtedly increases the ability to work, but if the stimulus is extreme the work is checked or inhibited altogether. For example, extreme anger, stage fright and even extreme joy, in the presence of the group, may inhibit the mental activity.

In many individuals at least the presence of the group is a stimulus to greater concentration of attention. In case others are doing the same thing, this helps us attend better to the activity in hand; and even in case others are doing something different, the distraction itself is sometimes a stimulus to better attention, because the individual tries to resist the distraction and there is an over-compensation which improves the attention. Meumann, for example, has found this result in certain experiments.

Meumann emphasizes particularly this compensation power of attention. Not merely is it true that the performance of an individual often increases when there are disturbing stimuli, because the increased concentration to overcome the distractions increases the work; but more than this, the compensation, which in this case becomes an over-compensation, shows that the disturbing stimulus has the effect of increasing rather than decreasing the energy, that is, it has a dynamogenic effect, although this effort does not occur in case of all individuals.

The measure of this is of course the increase of the performance by the distracting stimulus. This is very well shown with the distraction stimulus when one is committing to memory. By Meumann's method the memory span or the number of figures or letters that can be remembered without error after once hearing is determined, and then disturbing stimuli are introduced. An acoustic stimulus may be introduced for distraction, *e. g.*, a metro-

nome strikes. Such a distraction often improves the performance.

To describe the stimulus to the imagination from the group would be commonplace. We need not go to the laboratory nor cite the case of children for illustration. The man in the crowd has always been able to see what has happened and more besides, to foresee impending danger, or anticipate success, or hear voices from the unknown and behold inspiring visions. We need not, I think, go back to ancient history for illustrations of even the latter. A week ago in my home city thousands of people watched for mysterious lights in the heavens, and not a few saw them and knew exactly what they meant. Nor was this the only place where men saw the moving lights of airships. Even of the groups on Boston Common it was reported that the clear rays of a moon approaching the full failed to undeceive "those who, having seen, believed, or believing that they had seen refused to doubt, or not having seen, had met and talked with those who had seen, or believed they had seen or had met those who had seen."

As regards the relative merits of solitude or a social environment for scholastic pursuits I am not concerned here to speak. But the weight of evidence thus far seems to be to indicate the advantage of group work, except when individual and original thinking is required. This is perhaps one reason why the man of genius has frequently desired solitude. There are undoubtedly, also, great individual differences as regards the effect of social environment; there are even perhaps different types as regards the effectiveness of the stimuli from the social group. There may perhaps be one type that does its best work in solitude, another type that does its best work in the group. This again is one of the problems that should be investigated.

Again, of course, the question is relative to the kind of work done. Mayer's experiments indicate that for some kinds of work the stimulus of the social group is needed. For some kinds of work, especially where original thinking is demanded, the environment of solitude is better.

What we may call the social stimulus to mental activity is such a commonplace matter that probably very few realize its significance. When, however, we recall the fundamental character of our social instincts it is not strange that the presence of other people should be a most potent stimulus either increasing or checking the mental activity. Psychologists have always recognized the fundamental character of the stimulus from ambition, rivalry and the like. But this social stimulus goes much farther back and is rooted in the reflexes of the sympathetic nervous system that are correlated with emotion. This is well illustrated in experiments with animals. Mosso found in his experiments testing directly the sympathetic reflexes in the dog that the presence of the master in the room at once affected the reflexes; and Dr. Yerkes, of Harvard University, finds that in his experiments with dogs the presence of the experimenter is always likely to affect the results.

The fundamental character of the social stimulus is shown also in many fields of human activity according to one view of esthetics. The artist always works with the audience in his mind. The teacher also and the orator are apt to do much of their work with the class or audience in mind. I am not concerned here with the fact that this often becomes a grotesque and exaggerated mark of the profession but merely with this as an illustration of the fundamental character of what we have called the social stimulus.

In fact this social stimulus colors every-

thing. It is comparable only to the constant peripheral stimulation which is necessary to keep us awake; in like manner a social stimulus is necessary as an internal condition, as we may say, of consciousness.

Perhaps the fundamental character of this social stimulus is seen best in the case of persons who are in solitude. The pathetic devices of prisoners, for example, their custom of making pets of mice, flies, or anything found in their cells, and their interest in any form of activity—all these are attempts to make some symbolic substitute of activities having social value for the lack of direct social stimulus. The making of things having a social value seems to appeal to them.

Griffith, for example, says that solitary confinement is "so good an instructor that very little time is needed for teaching prisoners a trade. They go to work without squares, gravers, stamps, patterns or models. Every scrap of glass or metal, every nail and pin turns to account as a tool. Waste from the shop, bones from the kitchen, walnut, cocoanut and acorn shells," etc., serve as materials.[8] But this along with many other pathetic devices to which prisoners resort are means of saving them from the misery of solitude. This does not seem due entirely to the satisfaction of the instinct of activity, but in part to the satisfaction given symbolically to the social instincts.

The social instincts are so strong in children that if they are so unfortunate as to be largely isolated from others they are apt to create imaginary companions and to live in a dream world of society.

The aim of this paper is to present the problem. Let me for a moment, however, hint at a wider point of view.

The investigations referred to have chiefly concerned the mere presence or absence of other individuals performing similar tasks. In a true social group the relations are more vital. Each individual feels a responsibility and performs some service for the group. Here the stimulus is likely to be greater. Perhaps the greatest stimulus to mental activity from the group is social success to those who can achieve it.

Both experiment and observation have shown the great stimulus resulting from success in general. Social beings that we are, no form of success is so stimulating as a social success. When we reflect that under present conditions many of the children in our schools are so placed that a social success is impossible we see the significance of this point.

Not to mention the frequent domination of the class group by the teacher and the artificial relations often existing in our school recitations, as shown so vividly by Dr. Scott, the many defects of school children shown by modern studies in school hygiene often make social success impossible.

Among the pathetic tragedies of childhood are the cases of those who never can achieve success because of defect—the child with defective vision who can not see the blackboard, the deaf child who can not hear the teacher, the child tormented with headache or toothache, the child whose brain nutrition is reduced by nasal obstructions, the sensitive child, the misunderstood child, and the whole list of nervous defectives.

An important relation between the development and integrity of the sense organs and mental efficiency has been shown by a number of investigations. A large

[8] Small, Maurice H., "On some Psychical Relations of Society and Solitude," *Pedagogical Seminary*, April, 1900, Vol. 7, No. 1, pp. 13–69.

per cent. of those children who have defective hearing have often been found to be dullards. Also those suffering from adenoid growths are likely to be found in the class of dull children. And while myopic children are often found among those more precocious and studious in school work, this due, perhaps, to their lack of normal interest in things out of doors and muscular activities, those with eye defects often seem hopelessly dull.

It is evident that we are dealing with a problem fundamental in pedagogy and school hygiene. Every parent knows the leaden stupidity that at times comes over children, and every teacher has doubtless had experiences with at least a few cases of it in chronic form. This is the one defect which to many teachers seems hopeless. The only redeeming thing about stupidity seems to have been discovered by a German, who with rather a labored attempt at wit has said that the stupid children will make invincible soldiers, because the gods themselves fight in vain against stupidity; but what is impossible to the gods of pedagogy is sometimes possible to Hygeia. When stupidity is due to a defect of the sense organs, the difficulty can sometimes be removed by the simple device of seating the pupil in a favorable position; a surgical operation for an adenoid growth has removed the cause of stupidity in the case of many children; and frequently what the stupid child specially needs is enough to eat, or sufficient sleep, or rest from work imposed out of school hours, or perhaps the mere stimulus of social success. In any case the cause should be sought.

Thus the simple problem with which we started leads out into the wider problems of social hygiene and social pedagogy; and here I must leave it with the hope that it will be considered by teachers and studied further by investigators.

WM. H. BURNHAM

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THE PRINCIPLE OF RELATIVITY

AT the recent Boston meeting of the American Physical Society there was so much general interest in the principle of relativity and so many questions were asked me personally by those who had given the subject very little attention, that it seems timely to give a brief introduction to the subject on a somewhat simpler basis than I think has yet been attempted. The method employs several of the "non-mathematical" conceptions first introduced by Lewis and Tolman, but I think the demonstrations will be found even simpler than theirs.

The principle of relativity is one attempt, and by far the most successful attempt as yet, to explain the failure of all experiments designed to detect the earth's motion through space, by its effect on terrestrial phenomena. It generalizes this universal negative result into its first postulate, which is, *the uniform translatory motion of any system can not be detected by an observer traveling with the system and making observations on it alone.*

The second postulate is that *the velocity of light is independent of the relative velocity of the source of light and observer.*

At the very outset, it is important to realize that we have no long-standing experience with systems moving with velocities comparable with that of light, and therefore that primitive intuition may not be the very best guide in first introducing us to them. We might easily imagine a peasant scorning the suggestion that the dimensions of a rigid body changed with the temperature, and declaring, on being

pressed that such an idea was clearly against common sense.

The whole principle of relativity may be based on an answer to the question: When are two events which happen at some distance from each other to be considered simultaneous? The answer, "When they happen at the same time," only shifts the problem. The question is, how can we make two events happen at the same time when there is a considerable distance between them.

Most people will, I think, agree that one of the very best practical and simple ways would be to send a signal to each point from a point half-way between them. The velocity with which signals travel through space is of course the characteristic "space velocity," the velocity of light.

Two clocks, one at A and the other at B, can therefore be set running in unison by means of a light signal sent to each from a place midway between them.

Now suppose both clock A and clock B are on a kind of sidewalk or platform moving uniformly past us with velocity v. In Fig. 1 (2) is the moving platform and (1) is the fixed one, on which we consider ourselves placed. Since the observer on platform (2) is moving uniformly he can have no reason to consider himself moving at all, and he will use just the method we have indicated to set his two clocks A and B in unison. He will, that is,

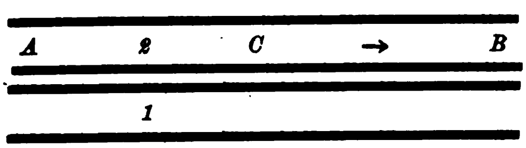

Fig. 1

send a light flash from C, the point midway between A and B, and when this flash reaches the two clocks he will start them with the same reading.

To us on the fixed platform, however, it will of course be evident that the clock B is really a little behind clock A, for, since the whole system is moving in the direction of the arrow, light will take longer to go from C to B than from C to A. Thus the clock on the moving platform which leads the other will be behind in time.

Now it is very important to see that the two clocks *are in unison for the observer moving with them* (in the only sense in which the word "unison" has any meaning for him), for if we adopt the first postulate of relativity, there is no way in which he can know that he is moving. In other words, *he has just as much fundamental right to consider himself stationary as we have to consider ourselves stationary*, and therefore just as much right to apply the midway signal method to set his clocks in unison as we have in the setting of our "stationary clocks." "Stationary" is, therefore, a relative term and anything which we can say about the moving system dependent on its motion, can with absolutely equal right be said by the moving observer about our system.

We are, therefore, forced to the conclusion that, unless we discard one of the two relativity postulates, the simultaneity of two distant events means a different thing to two different observers if they are moving with respect to each other.

The fact that the moving observer disagrees with us as to the reading of his two clocks as well as to the reading of two similar clocks on *our* "stationary" platform, gives us a complete basis for all other differences due to point of view.

A very simple calculation will show that the difference in time between the two moving clocks is[1]

[1] The time it takes light to go from C to B is $\frac{1}{2}/(V - v)$ and the time to go from C to A is $\frac{1}{2}/(V + v)$. The difference in these two times is the amount by which the clocks disagree and this

$$l/V\ \beta/(1-\beta^2)$$

where

$l =$ distance between clocks A and B;
$v =$ velocity of moving system;
$V =$ velocity of light;
$\beta = v/V$.

The way in which this difference of opinion with regard to time between the moving ing observer and ourselves leads to a difference of opinion with regard to length also may very easily be indicated as follows:

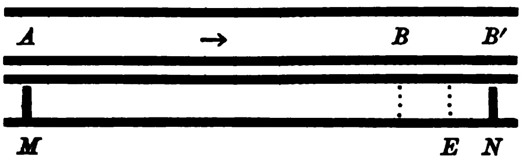

FIG. 2

Suppose the moving observer desires to let us know the *distance* between his clocks and says he will have an assistant stationed at each clock and each of these, at a given instant, is to make a black line on our platform. He will, therefore, he says, be able to leave marked on our platform an exact measure of the length between his clocks and we can then compare it at leisure with any standard we choose to apply.

We, however, object to this measure left with us, on the ground that the two assistants *did not make their marks simultaneously* and hence the marks left on our platform do not, we say, represent truly the distance between his clocks. The difference is readily shown in Fig. 2, where M represents the black mark made on our platform at a certain time by the assistant at A, and N that made by the assistant at B at a later time. The latter assistant waited, we say, until his clock read the same as clock A, waited, that is, until B was at B'; and then made the mark N. The moving observer declares, therefore, that the distance MN is equal to the distance AB, while we say that MN is greater than AB.

difference becomes, on simplification, the expression given above.

Again it must be emphasized that, because of the first fundamental postulate, there is no universal standard to be applied in settling such a difference of opinion. Neither the standpoint of the "moving" observer nor our standpoint is wrong. The two merely represent two different sides of reality. Any one could ask: What is the "true" length of a metal rod? Two observers working at different temperatures come to different conclusions as to the "true length." Both are right. It depends on what is meant by "true." Again, asking a question which might have been asked centuries ago, is a man walking toward the stern of an east-bound ship really moving west? We must answer "that depends" and we must have knowledge of the questioner's view-point before we can answer yes or no.

A similar distinction emerges from the principle of relativity. What is the distance between the two clocks? Answer: that depends. Are we to consider ourselves with the clock system when we answer, or passing the clocks with a hundredth the velocity of light or passing the clocks with a tenth the velocity of light? The answer in each case must be different, but in each case may be true.

It must be remembered that the results of the principle of relativity are as true and no truer than its postulates. *If future experience bears out these postulates then the length of the body, even of a geometrical line, in fact the very meaning of "length," depends on the point of view, that is, on the relative motion of the observer and the object measured.* The reason this conclusion seems at first contrary to common sense is doubtless because we, as a race, have never had occasion to observe directly velocities high enough to

make such effects sensible. The velocities which occur in some of the newly investigated domains of physics are just as new and outside our former experience as the fifth dimension.

Returning now to the magnitude of this difference of opinion as to the distance between the clocks, it is easy to show that, from our point of view, the moving observer overestimates the distance in the ratio

$$1/(1-\beta^2).$$

So that it may be said in general that lengths in the direction of motion, which *he* says are equal, *we* say are unequal in this same ratio.

On lengths perpendicular to the direction of motion our estimates agree.

Now let us ask ourselves: What are *corresponding lengths* in the two systems? Corresponding lengths may with propriety be given the same name, "meter" for instance. The condition that two lengths should be "corresponding" is simply that each observer comes to the same conclusion with respect to the *other* length.

The lengths AB and MN are not "corresponding," for the moving observer says that MN is *equal* to AB, while we say AB is *less* than MN, in the ratio $(1-\beta^2)$. If, however, we mark off on our platform a length which is a mean proportion between our estimate of the length AB and the length MN, this length, say ME, will "correspond" to the length AB, for we shall then say, that AB is less than ME in the ratio $\sqrt{1-\beta^2}$, while the moving observer will say that ME is less than AB in the same ratio.

Thus any length, in the direction of motion, on a moving system is estimated less in the ratio $\sqrt{1-\beta^2}$ by a "stationary" observer.

Or, put in a better way, *an observer viewing a system which is moving with respect to him, sees all lengths, in the direction of motion, shrunken in the proportion $\sqrt{1-\beta^2}$, where β is velocity with which the system is passing him in terms of the velocity of light.*

We have now reached two results, which we may summarize thus; first, clocks which a moving observer calls in unison do not appear in unison to a "stationary" observer, the clock in advance as regards motion appearing behind the other in time, and second, distances in the moving system appear shortened in the direction of motion in the ratio $\sqrt{1-\beta^2}$. In the above we can, of course, interchange the words "moving" and "stationary."

Next let us turn our attention to the unit of time in each system. *It is not hard to show that the unit of time in the moving system will appear to us greater than ours in the ratio* $1/\sqrt{1-\beta^2}$. This is due to the fact that in the moving system forward clocks are behind in time.

In the measurement of time we assume a certain standard motion to be taking place at a constant rate and then take as a measure of time the total displacement which this motion has caused. Time measurement with an ordinary clock is obviously a special case of this general rule.

The moving observer can adopt as his unit of time the time it takes light, moving with the characteristic[2] space velocity V, to travel a certain distance d and return to him.

Suppose d is in the direction of motion, and the light after traveling a certain distance in the direction of motion is reflected back to the observer. He will then write

$$t = d/V.$$

We, however, "know" that he is overestimating the distance d in the ratio $1/\sqrt{1-\beta^2}$

[2] That the moving observer's estimate of V can not change with his velocity follows of course from the first postulate.

and overestimating also the average velocity with which his signal *travels through his system* in the ratio $1/(1-\beta^2)$,[3] thus he is *under*estimating his time in the ratio $\sqrt{1-\beta^2}$. A certain time interval, that is, appears less to him than to us and hence his unit of time appears to us *greater* than ours in the ratio $1/\sqrt{1-\beta^2}$.

This paper has become long enough without an attempt to discuss the units of mass and force. It has been my purpose merely to answer a number of questions which the experience of the Boston meeting led me to believe were in the minds of many who had not given the subject enough thought to understand easily the more profound discussions.

The apparent transverse mass is, I think, best derived by Lewis and Tolman[4] in their excellent paper on the principle of relativity, and the relation between transverse and longitudinal mass is shown in the most direct and simple way by Bumstead[5] making use of the torsion pendulum. Any one interested in the subject should read these two papers.

It is, of course, true that the principle of relativity has a much deeper logical significance than the simple, more or less concrete conceptions on which it is based in the present paper would lead one to suppose, but in an introduction to such a subject concreteness may not be a fault.

It should be restated that the results of the principle for uniform translation are simply as true as its two postulates. If either of these postulates be proved false in the future, then the structure erected can not be true in its present form. The question is, therefore, an experimental one.

I think it may be said with fairness, however, that the principle is already in harmony with so many phenomena that the burden of proof lies with those who object to it. Besides the negative result of experiments to detect the earth's motion the principle is supported directly by the recent experiment of Bucherer,[6] and by the still more recent experiment of Hupka.[7] Indirect support is also given by Lewis's[8] independently derived theory of non-Newtonian mechanics, which agrees exactly with relativity results, and by Comstock's[9] deductions from orthodox electromagnet theory which lead to conclusions so nearly coincident with those of relativity as to be very suggestive.

In closing, a word should be said with regard to the "addition of velocities" according to relativity rules. It will be evident on a little thought that if the moving platform of Fig. 1, which is *passing us* with velocity v, has on it a body *traveling over it* in the direction of its motion with velocity v (that is, with a velocity which the observer on the moving platform calls v), then *our* estimate of the velocity *of the body* will *not* be $v + v_1$. The reason is of course that $v + v_1$ is the sum of two quantities, one of which is estimated by us and the other by the moving observer. We should, therefore, be inconsistent because we should have mixed view-points. *Our* estimate of the platform's velocity plus *our* estimate of the body's velocity with respect to the platform equals *our* estimate of the

[3] The average velocity of a signal traveling through his system with a velocity which we estimate as $V - v$ in one direction and $V + v$ in the other, is of course obtained by dividing the total distance by the total time. The total time is obviously

$t = \frac{1}{2}$ distance$/(V-v) + \frac{1}{2}$ distance$/(V+v)$,

and hence the average velocity is

$$V_a = V(1-\beta^2).$$

[4] *Phil. Mag.*, 18, 510–523, 1909.

[5] *Am. Jour. of Science*, 26, pp. 493–508, 1909.

[6] *Ann. d. Phys.*, 28, S. 513–536, 1909.

[7] *Ann. d. Phys.*, 31, S. 169–204, 1910.

[8] *Phil. Mag.*, 16, pp. 705–717, 1908.

[9] *Phil. Mag.*, 15, pp. 1–20, 1908.

body's velocity. In this last case we have stuck to one point of view and obtained a correct result.

This feature connected with the so-called "addition of velocities" is what Professor Michelson and others so strongly object to in the relativity principle, but the result is a perfectly natural one as soon as we have seen the admissibility of more than one point of view and the difference in estimates caused thereby.

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Massachusetts Institute of Technology

SOME CONSIDERATIONS AS TO THE NATURE OF COMETS AND THEIR PROBABLE RELATION TO THE SUN

The ideas herein put forward are not all original with the author, though it is believed some of them may be. It is hoped that the considerations may, however, help to a simple rational understanding of the major facts regarding the behavior of comets.

The exceedingly high temperature of the sun causes it to be surrounded by an atmosphere of vapors. Some of the vaporized matter condenses in the outermost layers and eruptions are constantly occurring which partly fill the space around it with very fine particles, the smaller of which are repelled by the pressure of the sun's radiation, which pressure even overcomes the gravitative force of the sun itself. These ejected particles probably constitute the streamers which are visible during total eclipses as extending from the sun to immense distances. What we see is the effect of innumerable overlapping streams. Their extreme tenuity is evidenced by the comparatively feeble luminosity in spite of the great depth of the flux which we are at any time observing. This depth is, of course, greater than the diameter of the sun. Such coronal streamers are by no means uniformly distributed about the sun, but in certain directions, varying continually, may be more dense than in others, coinciding perhaps with great eruptive areas of the sun's surface. It probably happens that when the outbreak is unusually violent, and when the earth happens to be passing through that part of space occupied by an abnormally extended streamer, an aurora of greater or less intensity or duration may attend the sweeping of the earth by such a streamer. The particles are probably ions or carry electric charges, and induced auroral streamers in the earth's atmosphere are for the time being visible on its dark side away from the sun.

It has been thought that comets may act in a somewhat similar way to disclose the condition of the ejected material of the sun, or, as may be conceived, to disclose a stratification or unevenness of distribution of the ejected matter from the sun. Since there is reason to believe that much of this matter is in a highly electrified state, it is not to be doubted that electrical phenomena are at the same time produced, with accompanying evolution of light. Indeed, in the free space around the sun, there must be a great intensity of ultra-violet radiation which of itself would cause emission of negative ions from matter in its path and produce electrical disturbances. But aside from this possibility, the comet is recognized as an assemblage of particles larger or smaller, moving in an orbit which involves great variations of its distance from the sun. In passing through the depths of space far away from the sun, these parts or particles may tend, by their very feeble gravitative effect, to gather up any finer particles which, on account of the intense cold of space, are substantially solid, even though at ordinary temperatures they would be gaseous. The parts of the comet's nucleus more or less porous would in this way accumulate upon their surfaces and in their pores occluded gases, condensed material and fine dust, and there would be a period of many years in which this gathering-up process, as in the case of Donati's and other long-period comets, could occur. Let a comet as an assemblage of such small masses after its long course through remote space, during which it has gathered fine particles ejected from the sun or from other bodies, reach, in

approaching the sun, a part of its orbit where the temperature given by the solar radiation to the surfaces of the masses is sufficient to boil off or regasify the condensed material; then not only is the gas blown off into vacuous space around the nucleus of the comet, but it is naturally blown off in the direction towards the sun, from the heated side of each mass, and at the same time that the gas leaves the mass other fine particles are lifted by the force of the escaping gas. This is due to the fact that these fine or dust-like particles are not held with any strong gravitative tendency. Ultra-violet radiation may also add its effect in causing discharge of negative ions. The result of this is that jets or flows of materials from the nucleus tend into the vacuum towards the sun from the warmed or radiation absorbing surfaces of the comet's nuclear masses. As soon as they leave the nucleus or the warmed surfaces, they are again cold and mainly condensed. But, though exceedingly fine, they are now absorbers, more or less solid, of the sun's radiation, and are gradually thrust backward by the pressure of the light and radiation and are blown off in the opposite direction by this pressure, so forming a tail in the contrary direction from the sun, or in a direction opposite to that in which they were first ejected. There being in matter all grades of volatility, as the cometary body approaches the sun, material more and more refractory, so to speak, would be evolved, until finally, if the approach is near enough to the sun, even ordinarily solid substances would be vaporized from the nuclear masses and projected to form a tail, as has just been described. Some of this vaporized matter would immediately condense on getting a little farther away, and form solid particles in the tail. The comet of January, 1910, showed sodium lines, showing that the temperature of the nuclear masses had probably reached the vaporization point of sodium. The greatest extension of a comet's tail usually comes just after the comet passes perihelion, because the heating process keeps on, as it were, a little past perihelion, just as the hottest part of our summer days is two or three o'clock in the afternoon. Now if the comet stays in proximity to the sun long enough, it will have discharged nearly all of its volatile material for a particular temperature reached. But on leaving the sun after the tail has shrunk (which is a very natural thing for it to do when the body passes through regions less heated by solar rays), it may again be in the condition to gather up the condensed and practically solid gases and vapors in the space around it. And if its period is a long one, such as 2,000 years, as in the case of Donati's comet, it should not surprise us if there is sufficient material to form a fair tail, which only lasts a few weeks at the most. Then it must be borne in mind, too, that an extremely small amount of material diffused in space under solar radiation will suffice to form a very large tail, as every particle, even of extremely small mass, becomes substantially a light source. Take, for instance, the amount of tobacco smoke that can cloud up a room when the sun is shining in it, and it will be found to be a very small quantity, but, if the room be black as night and a hole be made in a shutter through which a small beam of sunlight enters and the minutest body of smoke be diffused in the room, there will be a "comet's tail" extending from the opening across the room where the sunbeam passes because it will be seen in blackness and that is the condition of our seeing comets' tails; in the darkness of night. Then we must remember how deep the space is which is occupied as a visible thickness in a comet's tail, say, 50,000 miles. We thus get an idea of how *free* of particles space must be *not* to shine with a luminosity equal to that of a comet's tail when we look off into the dark night irradiated by the intense solar beams.

Doubtless the simple view here given is complicated by many other actions, electric, etc. Comet's tails sometimes vary greatly and rapidly. We need not be surprised at this when boiling points are known to be critical; when, in other words, a few degrees increase in temperature may vaporize a substance

which would not otherwise have been vaporized. Furthermore, it is quite possible that the comet, in moving around the sun, entangles itself in the stream of material driven from the sun and varies in its effects in accordance with its being or not being in a solar streamer more or less dense for the time being, speaking relatively. It is easily conceivable that an assumed stratification of space may be a cause of variations of comet's tail brightness. Putting it more properly, it is conceivable that a comet may act as an indicator of the condition of space around the sun, the space in which the comet, for the time being, is moving. Even under the idea that there is volatile matter emitted from the sun which ordinarily would not be visible, let such matter strike into the nucleus of a comet and meet matter from the comet itself; it is easily seen that interactions, electrical or otherwise, or even physical collisions, may add to the light of a comet's tail.

The chief point, however, which I have endeavored to emphasize by the comparisons above made, is the excessive tenuity of the matter which would be sufficient to give rise to a brilliant appendage to a comet and the exceedingly small amount of volatile matter needed. This fact renders it possible that the comet may, in the lapse of many years, replenish itself in the depths of space and may account for the fact that at each return, even to close proximity to the sun, a tail is developed. Otherwise, since the matter of the tail certainly does not return to the comet, it would seem that the volatile matter would be distilled off and lost in a very few perihelion passages.

ELIHU THOMSON

ROBERT PARR WHITFIELD

PROFESSOR ROBERT PARR WHITFIELD died on April 6 at Troy, N. Y., in his eighty-second year.

Professor Whitfield's association with the progress of paleontological science in the United States has placed his name permanently among the pioneers of that science in this country. His work, however, has no antiquarian interest merely. From the first it was forcible, careful and convincing. Throughout the long period of his connection with the American Museum of Natural History he industriously contributed papers on invertebrate paleontology, to the publications of that institution, while his work on the surveys of Ohio, Wisconsin and New Jersey was persistently prosecuted, in reports of great value, distinguished always by keen morphological discrimination.

His work began with his employment on the New York State Survey, where he assisted Professor James Hall, who was then engaged in his studies of Paleozoic fossils. Professor Whitfield's assistance was at first in the nature of exact preparatory analyses of the copious material offered for examination, classification and description. About this time he produced the beautiful illustrations of graptolites which gave distinction and an unusual interest to the decades of the Canadian Survey, and his painfully minute study upon which superinduced a, fortunately, only momentary, danger to his eyesight. He continued his labors on the survey until 1877, and helped materially to give precision and a broad zoological basis of comparison to the reconstructions of the invertebrate life of the past, in the papers and volumes, written by Professor Hall, not only upon the paleontology of New York, but of western states as well. His studies of the internal loops of various genera of brachiopoda, his delineation of the muscular scars of lingula and his rearrangement of the crinoidal scheme of plates were all very helpful. Succeeding this came his admirable descriptive papers published in the geological reports of Wisconsin and Ohio. Then followed an exhaustive examination of the upper Devonian lamellibranchs, the results of which were embodied in the subsequent New York survey volumes on these shells.

When the great Hall collection of fossils came into the possession of the American Museum, Professor Whitfield was invited to take charge of this extraordinary cabinet, to

install, arrange and label it. It would have been impossible to have found any one so well qualified for this task; he seemed to recognize every specimen as it was unpacked and each one became the text of pleasant or exciting memories.

It was not long after Professor Whitfield's assumption of this important charge that the publication of the *Bulletin* of the American Museum was begun, and paleontological papers from his pen appeared upon its pages. It is quite unnecessary to review all of these; they consisted of descriptions of new species, genera, revisions, notes, emendations and figures of hitherto unfigured species, and original identifications and discussions. Perhaps the most important were his descriptions of the fossils of the Fort Cassin beds in Vermont, his admirable treatment of the subject of *Uphantaenia* and *Dictyophyton*, referring these problematic bodies to sponges, a position firmly established by later observations, his detection of a fossil scorpion in the Waterlime beds of New York, his papers on Cretaceous Syrian fossils, on fossil marine algæ, on the Cretaceous Rudistæ of Jamaica and his review of the anomalous genus *Barrettia* from the same island. He occasionally intercalated in these fossil studies a paper upon living forms, as his experimental observations upon *Lymnea megasoma*, a new sponge from Bermuda and a new coral from the Bahamas.

He completed during these years his great work on the fossils of the Cretaceous and Tertiary of New Jersey, a work achieved under very serious difficulties, and with most fragmentary and insufficient material. These memoirs were published by the U. S. Geological Survey. The genus *Whitfieldia*, a member of the meristelloid brachiopods, was named by Professor Davidson after him, and his name as a specific designation appears up and down the pages of paleontographical literature. Unostentatious, of a reserved, almost severe demeanor, animated by an intense love of his science, his life was passed peacefully and pleasantly, amid unruffled domestic relations, in unbroken association with the objects of his conscientious and unremitting study.

L. P. G.

CONFERENCE ON AGRICULTURAL NATURE-STUDY

THE conference on the teaching of agriculture in the common schools of Illinois was held from March 24 to 26, an enthusiastic session at the University of Illinois at Urbana. This was the first meeting of its kind in the United States, and educators from all over the state of Illinois and neighboring states took part in its sessions. Among those present were D. J. Crosby, U. S. Expert in Agricultural Educational Work, Washington, D. C., and representatives of railroads, members of agricultural faculties from neighboring states, members of the legislature, county superintendents, normal school faculties, farmers' institute officials, rural school directors, domestic science leaders, manual training leaders, practical farmers and land owners, technical men, college and university professors, state departments of public instruction.

The conference was inclined to move slowly along this new line of activity. It took, however, two or three steps that are destined to be very important in the educational work of the schools of the state. It was strongly urged that a course of study in agriculture be planned for the elementary schools of the state. A committee was appointed for this purpose consisting of Professor Fred. L. Charles, University of Illinois; County Superintendent McIntosh, Monticello, Illinois; Miss Alice J. Patterson, State Normal University, Normal, Ill.; Assistant State Superintendent, U. J. Hoffman, Springfield, Ill.

It was arranged that a second meeting of the conference be held next year in connection with the agricultural short course at the University of Illinois, when something over a thousand people of the state will be assembled to study agriculture in its various phases.

The following standing committee was ap-

pointed by the conference to continue the organization and work of the conference: Assistant State Superintendent U. J. Hoffman, chairman; Anna L. Barbre, county superintendent, Taylorville; C. H. Watts, county superintendent, Champaign; Hon. J. B. Burrows, Decatur; Mrs. Scott Durand, Lake Bluff; Alice Jean Patterson, Illinois State Normal University; Professor W. G. Bagley, University of Illinois; Professor Fred. L. Charles, University of Illinois.

The above-mentioned committee presented the following resolutions which were unanimously adopted by the conference:

Resolved:

1. That this conference request and authorize Professor Fred L. Charles to appoint a representative committee to serve with him as chairman in the preparation of a course of study in agricultural nature-study which may be suitable for the eight grades of the elementary schools of Illinois.

2. That we may request those who are responsible for the conduct of the agricultural short course, that provision be made for a second meeting of this conference during the next annual short course at the university.

3. That this conference appoint a committee of three to enter into communication with the Illinois Farmers' Institute, through its committee on Agricultural Education in the public schools, to bring to its attention the urgent necessity of furnishing to the teachers of the elementary schools of the state all possible aid in the organization and adaptation of agricultural materials suitable to the purposes of these schools, and, further, to request that they take such action as they deem necessary to secure at the next session of the legislature ample funds to equip the University of Illinois, through its college of agriculture and school of education, to carry on the following most essential lines of work: (1) Research in the organization and method of nature-study and agriculture in the elementary schools; (2) the training of specialists within this field; (3) the publication of abundant literature for the use of the public schools; (4) the maintenance of a correspondence bureau to meet the rapidly growing demands from the teachers and elementary school interests of the state; (5) the establishment and maintenance of a bureau for the preparation and distribution of equipment and materials essential to instruction in this subject; (6) the employment of thoroughly competent demonstration teachers who shall be sent out into the state to assist in the introduction of this study in the elementary schools; (7) such other means of advancing this study as may later appear to be desirable.

The committee of three to communicate with the Farmers' Institute Committee was as follows: Hon. Joseph Carter, Hon. J. B. Burrows, Dean Eugene Davenport.

One interesting result of the work of this conference was the plan to assemble at the university model rural school equipments in agriculture, domestic science, hygiene and public health, and in manual training. The university is very fortunate in already being provided with an equipment in manual training. This model outfit for rural schools was presented to the university by the Bradley Polytechnic Institute of Peoria, and is the product of a study by Professor C. S. Van Deusen.

A statement has gone out to the papers that manual training in the schools had received a set-back in the discussions of this conference. The statement was entirely erroneous, nothing to that effect was even suggested.

REPORT OF AN INVESTIGATION OF THE PHENOMENA CONNECTED WITH EUSAPIA PALLADINO

THE undersigned had three sittings with the Italian medium Eusapia Palladino in the Physical Laboratory at Columbia University in January last. The object in view was to secure and report any evidence of the operation of hitherto unknown forces through her or in her presence.

Though the investigation may fairly be called patient and laborious, no convincing evidence whatever of such a phenomenon could be obtained. Many indications were obtained, however, that trickery was being practised on the sitters. These indications will be more fully stated by the individual investigators.

So far as these sittings afford data for judgment, the conclusion of the undersigned

is unfavorable to the view that any supernormal power in this case exists.

CHARLES L. DANA, M.D., *Professor of Nervous Diseases, Cornell University Medical College.*
WILLIAM HALLOCK, *Professor of Physics, Columbia.*
DICKINSON S. MILLER, *Professor of Philosophy, Columbia.*
FREDERICK PETERSON, M.D., *Professor of Psychiatry, College of Physicians and Surgeons, Columbia.*
WALTER B. PITKIN, *Lecturer on Philosophy, Columbia.*
AUGUSTUS TROWBRIDGE, *Professor of Physics, Princeton.*
EDMUND B. WILSON, *Professor of Biology, Columbia.*
ROBERT WILLIAMS WOOD, *Professor of Physics, Johns Hopkins.*

It has been said that Eusapia finds trickery more easy than the exercise of her supernormal power; that she consequently resorts to the former whenever the control by the sitters permits it; and that the only fair test is had when there is such control as makes trickery absolutely impossible. During a fourth sitting, at which the undersigned were present, something like this control was exercised; and while this was the case none of the so-called evidential phenomena took place.

C. L. Dana, W. Hallock, D. S. Miller, F. Peterson, W. B. Pitkin, E. B. Wilson.

We take this opportunity of making our acknowledgments to Professor Hallock for his courtesy in putting his private office and workshop at the disposal of the investigators; and to the members of the groups at large for giving their time to the sittings in the midst of professional duties, in especial to those who came from a distance. We wish to record our regret that, owing to circumstances beyond our control, the X-ray test, ingeniously devised by Professor Wood, could not be applied.

W. P. MONTAGUE,
W. B. PITKIN,
D. S. MILLER

I have been present at nine sittings with Eusapia and in an adjoining room at a tenth. Broadly speaking, her "phenomena," as observed in America and as reported before, fall into seven classes: (1) levitations of a table, (2) rappings, (3) touches, (4) breezes, (5) lights, (6) "materializations," (7) movements in and about the cabinet. With the lights I was not favored. Of all the other classes, I can say: (1) That conclusive and detailed evidence was gained as to the method by which typical specimens of them were repeatedly produced,[1] and (2) that when the medium was securely held they were not produced at all.

Statements of observations on essential points will, I trust, be published later. These include each of the classes named.

It may be asked, however, what we are to make of the results presented in the *Bulletin* of the *Institut Général Psychologique of Paris* and in the *Proceedings of the Society for Psychical Research.* Of these two documents it is, by common consent, the latter which presents the strongest body of evidence for Eusapia's supernormal power. The Paris committee had worked mainly to establish that the "phenomena" really occur and are not the mere hallucinations of the sitters. Of course they do occur; we must admit it. But the English committee try, by reporting in detail how the medium was held and watched, to give the reader evidence that the phenomena could not have been caused by trickery. The result is that we have the record of a long, hard and conscientious piece of labor. It is imposing. It seems at first to warrant the writers' unanimous "Yes, the thing is true." But read Richard Hodgson's comments on the case, written sixteen years ago when he was in consultation with Mr. W. S. Davis; or read Mr. W. S. Davis's article in the New York *Times* of October 17 last. Read one of these enough to grasp it; then attend one sitting; and the impressive effect of the English report has vanished. One finds himself able to point out on page after

[1] Accounts are presented in the article by Professor Jastrow in *Collier's Weekly* for May 14, 1910.

page how the writers were deceived. On page after page one finds them the victims of the old "substitution-trick." Examples of this will be given elsewhere. One can go through the report and write on the margin at almost every phenomenon (where the "control" is stated) by what hand or foot it was probably done. No substantial evidence remains.

Thanks are due to Messrs. W. S. Davis, J. L. Kellogg and J. W. Sargent, who have all had much experience, both of professional conjuring and of the investigation of mediums, and who gave their time and invaluable services at my last two sittings. Mr. J. F. Rinn, a merchant, who is a trained observer and an investigator of spiritualism, deserves special acknowledgments for his work as a watcher. DICKINSON S. MILLER

I agree substantially with the committee's report. My sittings with Paladino have failed to convince me that she possesses any unknown force. In fact, she has been detected in so much trickery that there is in my opinion an extremely high probability that all of the manifestations which I witnessed were produced by merely natural means. But I do not feel that the methods and conditions of our experiments were of such a kind as to warrant the rigorously scientific and finally conclusive verdict for which we had hoped, or even to justify quite the degree of emphasis expressed in the majority report.

It has long been known that Paladino resorted to trickery, and the claim has been made and will still be made that she finds it easier to perform fraudulently that which she can and sometimes does accomplish otherwise. The Cambridge exposure of 1895 proved that she used trickery, but did not put a stop to her scientific vogue. I had hoped, perhaps foolishly, that our investigation would be rather more than a repetition of something already accomplished. And it seemed plain that the policy to pursue was to insist upon conditions of control by mechanical means, which, instead of encouraging fraud by their looseness, should be so rigorous as absolutely to eliminate her well-known tricks of foot and hand substitution.

If this plan had had a fair trial, and no "phenomena" had resulted, our report might have given a permanent quietus to the Paladino cult. W. P. MONTAGUE

I sign the majority report, believing it correct as far as it extends. But it does not go far enough. It gains, I think, a certain fictitious importance through the absence of all those details about methods and results which are properly considered indispensable to any such statement made by scientists to scientists. Were those details here recorded, the difference between this report and the sort SCIENCE usually prints would instantly appear.

One may take either of two attitudes toward Eusapia and her like. Judge her by shrewd common sense, if you choose; then almost everybody will briefly pronounce her an egregious and unmitigated humbug, as I do when thus considering all that I have seen at seven of her seances. On the other hand, though, you may prefer to subject her phenomena to the strict scientific method; and now, having elected the intellectual game you are to play, you must observe its rules. If my understanding of the canons of induction is correct, the investigators sometimes unwittingly and sometimes unavoidably changed their point of view very often in the midst of their experiments with the result that their verdict, like my own, is based upon impressions and "human" probabilities. That these latter are very strong does not make the conclusions from them scientific. Perhaps it is not worth while trying to be scientific over such matters, but that is another issue. W. B. PITKIN

Professor Miller has asked me to add to the statement which I signed as a member of the committee, a personal report of the impressions made on me by the three sittings with Eusapia Palladino which I attended in January.

Judging from the earlier sittings which I attended on the invitation of Mr. Hereward Carrington, I should say that those held with the committee were fairly representative as

regards the class of phenomena which Palladino has attempted to produce in this country, though as regards quantity, rather than quality, they should be regarded as poor sittings.

I was particularly struck by an incident which occurred during the third sitting (January 22, 10:32 P.M.) which goes to show how very cautious one must be in accepting as evidential motions of objects apparently out of reach of the medium.

From 10:29 P.M. until 10:32 P.M. objects were moved in the cabinet behind E. P. while she was under the following conditions of control—feet tied together by a rope which prevented her from separating them by more than eight inches, in addition her ankles were held by one of the sitters who had taken up a position on the floor, each wrist tied to a wrist of her neighbor, on the right and left, by means of a rope which allowed her ten inches free motion in case she should elude the tactile control which her neighbors were endeavoring to keep. The light in the room at the time was that from a frosted electric bulb which I estimated to be giving about four candle power, placed about four feet from the medium's head.

It would seem that the objects moved in the cabinet were outside the range of free motion of her hands and feet and the motions seemed to be taking place under what might be called "test conditions." However, the shorthand report of this sitting shows that three of the sitters were convinced that the motions were caused by the medium knocking over objects in the cabinet with the back of her chair—I noted that so soon as her chair was moved openly a few moments afterwards more objects fell.

I mention this particular incident as I think it shows how difficult it is to obtain really "test conditions." Incidents of a similar character at other sittings I have attended, where at first sight the conditions of control seemed excellent, have rendered me extremely reluctant to base an opinion as to this remarkable woman on the very interesting reports of her numerous European sittings, but, so far as the evidence collected at the relatively uninteresting American series of sittings is concerned, I think it is decidedly unfavorable to Eusapia Palladino's pretensions.

AUGUSTUS TROWBRIDGE

After attending six sittings with Eusapia Palladino, I find myself in much the same position as at the start.

Many things have occurred which I find great difficulty in explaining by fraud while I have repeatedly seen trickery employed. I have succeeded in watching the manifestations within the cabinet throughout two entire evenings, the floor being illuminated with a feeble light which was thrown by means of a mirror through a crack between the bottom of the cabinet and the floor. The cabinet was of wood built into a doorway, so that it projected back into the adjoining room. My plan was to employ a powerful X-ray apparatus and a large fluorescent screen, so that a shadow picture of whatever was going on within the cabinet could be obtained in the back room at any instant without the knowledge of the medium.

The interior of the cabinet I viewed through a large hole cut in the top, reclining on a mattress placed on the top of an instrument case adjoining the doorway. The X-ray tube was placed within the instrument case and carefully muffled, the fluorescent screen three feet square was placed against the opposite wall of the cabinet, on the outside of course. This apparatus was never actually used, owing to the sudden termination of the sittings, but it was set up and thoroughly tested, and gave excellent satisfaction. I mention it as it may be of use to future investigators, for, if properly installed, it is proof against any fraud, as it can be used without the medium's knowledge.

From my position above the cabinet I saw that whenever anything in the cabinet was moved the curtain was pushed back, a black object reaching in from Palladino's back groping around and finally seizing the table. Those who believe in Eusapia's supernormal powers will say that this was the third arm.

I need not say that an X-ray picture of this third arm as seen on the fluorescent screen would be an interesting subject of study. It would not be difficult to so arrange the apparatus that the shadow of the medium's entire body could be obtained. The switch for operating the coil should be placed within reach of the observer on the top of the cabinet, so that the flood of rays need only be turned on when something is going on worth investigating. In this way no possible injury could result.

At the first sitting at which the illumination of the floor was tried Eusapia complained of this light, which appeared to be quite accidental. I accordingly constructed a grill of vertical strips of thin wood, painted black. The floor of the cabinet was covered with this. From her position in front Eusapia could not have seen the light on account of the grill, while the observer above, looking down directly between the strips, could see the illuminated floor without difficulty. The object of illuminating the floor was of course to obtain a luminous background against which moving objects could be seen. It proved to be a very effective way of investigating cabinet phenomena.

On two occasions the black object which appeared was pointed, on the third, when the table was seized it was blunt and rounded. Eusapia had pushed her chair back until her back was against the curtain, and I doubt if what I saw was the "third arm"! On the occasion when I held one of Eusapia's hands, nothing was disturbed in the cabinet, but some very fine levitations occurred, in a brilliant light, and I could not only see between the medium's knees and the legs of the table, but passed my other hand between them and her skirts. I felt very positive that the legs of the table were free from contact with any part of her person.

The proper system of investigation, in my opinion, is the one outlined. Whenever I saw anything going on in the cabinet, I sent an electric signal to seance room, so that particular pains could be taken by the persons holding her hands, to see whether the contact had been broken at the moment.

If the phenomena are genuine it can be proved by the X-rays, I think, *and in no other way*. Madam Palladino need have no fear of the X-ray test, if the thing seen in the cabinet is a supernormal third arm. If the sittings had not been suddenly terminated, I feel certain that at the next one we should have had a complete explanation of how the disturbance in the cabinet was created. I am quite ready at any time to aid Madam Palladino in establishing the genuineness of her supernormal powers by means of the X-rays.

R. W. Wood

THE CARNEGIE FOUNDATION

The following letter has been addressed to the trustees of the Carnegie Foundation for the Advancement of Teaching:

Columbia, Mo.,
March 9, 1910.

To the Board of Trustees of the Carnegie Foundation for the Advancement of Teaching.

Gentlemen: At a largely attended meeting of members of the faculties of the University of Missouri it was voted that the following communication be addressed to your board as a body, and to its individual members:

The purpose of the foundation of which you are the administrators, as set forth in the expressions of the founder and in subsequent official statements of the trustees, are "to serve the cause of higher education by advancing and dignifying the profession of the teacher in higher institutions of learning," especially with a view of rendering that profession attractive to increasing number of able men. Through the desire of many institutions to enjoy the benefits of the foundation, it has come to be also an important instrumentality for influencing and coordinating the educational policy of a considerable number of American universities and colleges. It is evident that these functions, of great potential usefulness, can in the long run be successfully performed only if the management of the foundation retains the confidence and sympathy of university officials and of the general body of university teachers. Though the foundation may do something to increase the material comfort in old age of some

members of the teaching profession, it can not accomplish its announced primary purpose unless its activities are such as, in the opinion of the majority of university teachers, actually tend to advance and dignify their profession. And it can not long retain the beneficial influence which it may properly exercise over the policies of institutions, unless their faculties and governing boards continue to believe that the foundation will fulfill the promises implied in its rules.

Certain recent acts of the foundation appear to us to be not only inequitable in themselves but also to be likely to destroy the confidence of university teachers and university boards in the stability of the foundation's policy, in the trustworthiness of its announcements, and in the general tendency of its work to render the profession more attractive to young men of independent spirit and high ability. While we do not feel called upon to express any opinion concerning the intrinsic desirability of a general and unqualified system of length-of-service pensions, we consider the abrupt abolition of such a system, without notice, after individuals and institutions have for four years been basing their acts upon the foundation's announcement that it would grant such pensions, to be unfair to those directly affected and provocative of indignation in nearly all teachers not directly affected. We, therefore, respectfully request that your board, as early as may be convenient, reconsider its action upon this matter. We believe, also, that further legislation is desirable, with a view to reassuring the academic public against the anticipation of other sudden and radical changes of the foundation's policy, and with a view to promoting a better and more sympathetic understanding between the management of the foundation and the general body of teachers.

While we do not desire to suggest the details of the legislation to be adopted, we are of the opinion that some such measures as the following would make for the advancement of the teaching profession, and therefore for the realization of the purposes of the foundation:

1. The adoption by your board of such supplementary legislation as shall effectually safeguard the interests of those who have, during the past four years, been influenced in the conduct of their affairs by expectations aroused by the old service-pension rule.

2. The adoption of a new rule, whereby no essential changes may be made in any of the fundamental rules of the foundation without several years' notice, duly promulgated to all of the institutions upon the accepted list.

3. The inclusion in the membership of the board of trustees of representatives of the teaching branch of the profession.

All of which is submitted to your favorable consideration.

C. STUART GAGER,
W. I. DAUMFORD,
H. B. SHAW,
Committee

SCIENTIFIC NOTES AND NEWS

PROFESSOR SVANTE ARRHENIUS, of Stockholm, has been appointed Silliman lecturer at Yale University.

DR. GEORGE E. HALE, director of the Mount Wilson Solar Observatory, has been elected an honorary member of the Royal Institution, London.

CAMBRIDGE UNIVERSITY will confer honorary degrees this term on Sir Oliver Lodge, F.R.S., principal of the University of Birmingham, and Professor W. H. Perkin, F.R.S., professor of organic chemistry in the Victoria University of Manchester.

AT the meeting of the Royal Society on May 5 the following candidates for fellowship were elected into the society: Mr. J. Barcroft, Professor G. C. Bourne, Professor A. P. Coleman, Dr. F. A. Dixey, Dr. L. N. G. Filon, Mr. A. Fowler, Dr. A. E. Garrod, Mr. G. H. Hardy, Dr. J. A. Harker, Professor J. T. Hewitt, Professor B. Hopkinson, Dr. A. Lapworth, Lieutenant-Colonel Sir W. B. Leishman, Mr. H. G. Plimmer and Mr. F. Soddy.

AT a meeting of the American Academy of Arts and Sciences, held on May 11, it was voted to award the Rumford premium to Charles Gordon Curtis "for his improvements in the utilization of heat as work in the steam-turbine."

DR. F. L. CHASE has been appointed acting director of the Yale Observatory.

PROFESSOR FREDERIC P. GORHAM, of the biological department of Brown University, has been appointed by the commissioners of shell fisheries of the state of Rhode Island to make a study of the distribution of the sewage in

Narragansett Bay in relation to the oyster beds.

Mr. P. H. Cowell, F.R.S., chief assistant in the Royal Observatory, Greenwich, has been appointed superintendent of the Nautical Almanac, in succession to Dr. A. M. W. Downing, who has retired.

Professor Fitzgerald has resigned the chair of engineering in Belfast University.

Dr. Harvey W. Wiley, chief of the Bureau of Chemistry, U. S. Department of Agriculture, has been elected president of the American Therapeutical Society for the coming year. The next meeting of the society will be held in Boston in May, 1911, under the auspices of the Harvard Medical School.

The Pennsylvania Chapter of the Society of the Sigma Xi has elected Professor I. J. Schwatt president, and Professor Wm. Easby, vice-president for the year 1910–11.

Mr. J. B. Tyrrell has been elected president of the Canadian Institute.

Mr. Alban Stewart, of the botanical staff of the New Hampshire College, has spent more than a year on the Galapagos Islands, making botanical notes and collections, which he has since worked up for publication at the Gray Herbarium of Harvard University, under the direction of Dr. B. L. Robinson.

Dr. Louis A. Bauer gave an address, under the auspices of the Joseph Leidy Scientific Society, "On the Cruise of the *Carnegie*," on May 10 before the students of Swarthmore College.

Mr. Douglas Mawson, professor of geology at the University of Sydney, is passing through the United States on his way to Australia.

It will be remembered that Mr. Henry Wilde, F.R.S., D.C.L., D.Sc., who had already founded at Oxford the Wilde readership in mental philosophy, the John Locke scholarship, and the Wilde lectureship in natural and comparative religion, established recently an annual lecture on astronomy and terrestrial magnetism, to be called the Halley lecture, "in honor and memory of Edmund Halley, some time Savilian professor of geometry in the university and astronomer royal, in connection with his important contributions to cometary astronomy and to our knowledge of the magnetism of the earth." Dr. Wilde delivered the first lecture on May 10, the title chosen by him being "On Celestial Ejectamenta."

It is announced that the erection of a laboratory for research in chemistry at Harvard University to be dedicated to the memory of Dr. Wolcott Gibbs is now assured. The small residue required has been underwritten by a friend. The site of the laboratory will probably be near the University Museum.

Dr. Noah Knowles Davis, professor emeritus of philosophy in the University of Virginia, has died at the age of eighty years.

Sir William Huggins, eminent for his contributions to astrophysics, past president of the Royal Society and of the British Association for the Advancement of Science, died on May 12, at the age of eighty-six years.

By action of the trustees of the Missouri Botanical Garden, five research fellowships in the Henry Shaw School of Botany have been established, each carrying an allowance of $500 per year. In memory of the late president of the board of trustees of the garden, who had held that office from the organization of the board until his death this spring, these are to be known as the Rufus J. Lackland Research Fellowships.

Reuter's agent at Georgetown, British Guiana, says that Sir Francis Lovell, dean of the London School of Tropical Medicine, has concluded his tour in the West Indies. His appeal for subsidies for the school from the various governments has been successful, useful sums being promised from all the British possessions. Barbadoes has promised £50 a year; the Windward Isles £50; the Leeward Isles £100; Jamaica £100, and Trinidad £100, and there is every likelihood that British Guiana will undertake to give a contribution.

In a report of the committee appointed by Provost Harrison, of the University of Pennsylvania, to consider plans for the future

operation of the Phipps Institute, it was recommended that its future policy embrace three fields of activity, and be reported by three correspondent departments—the laboratory, clinical and sociological departments. Work of the laboratory will be devoted principally to the discovery or formulation of some specific remedy for the treatment of tuberculosis. The program outlined for the clinical and sociological departments is divided into four parts: (1) The clinical and social work in allotted districts; (2) social research; (3) general educational work; (4) the stimulating of the public to action.

CONGRESSMAN MANN has introduced two health bills in the House of Representatives. One is a bill to enlarge the Public Health and Marine Hospital Service, changing the name to "The Public Health Service," while continuing it under the Department of the Treasury. The bill creates a division of water supply, to investigate the pollution of streams, and confers authority to investigate tuberculosis, typhoid fever and other diseases. The other is a bill embodying the original suggestions of the Committee of One Hundred before Senator Owen's plan for a department was presented. This makes, at least, six important public health bills now before congress, the other four being the Owen bill (S 6049) in the senate, the same bill in the house introduced independently by Congressmen Creager and Hanna, and a modification of the Owen bill introduced by Congressman Simmons.

AT the decennial convention for the Revision of the Pharmacopœia, held in Washington, D. C., on May 10, Dr. H. W. Wiley was elected president and Dr. Joseph P. Remington was made chairman of the revision committee of fifty which will be divided into fifteen sections to which are assigned specific subjects. The next meeting of the committee will be in 1920, but the work of revision is already under way and will be pushed as rapidly as possible. The delegates to this convention are accredited representatives of incorporated medical and pharmaceutical associations and colleges and of such other scientific societies and federal officials as are specifically named in the constitution, for example, the American Chemical Society and the surgeon-generals of the Army, the Navy and the U. S. Marine-Hospital Service. By amendment to the constitution at the last meeting the following additions were made to the list of officials and organizations authorized to appoint delegates: the Secretary of Agriculture, the Secretary of Commerce and Labor, the Association of Official Agricultural Chemists, the Association of State and National Food and Dairy Departments, the Wholesale Druggists Association and the National Dental Association.

THE School of American Archeology will continue during the year 1910 the work of exploration and excavation of ancient ruins with collateral ethnological and historical work in New Mexico, Utah, Arizona and Central America. The season for work in the southwestern part of the United States is from June 1 to November 1; in Central America it is from December 1 to May 1. Properly qualified persons will be admitted to the field expeditions of the school or to undertake research work under its direction in Santa Fé or elsewhere, on satisfying the staff of their ability for original investigation. Those who desire to undertake such work should write the director, Mr. Edgar L. Hewett, stating his or her wishes, giving such information as to qualification as would naturally be needed and stating when and for what length of time they desire to take up the work.

DURING the week of May 30–June 4 a party of students from the college of agriculture of the University of Wisconsin, under the direction of several members of the faculty, will inspect some of the fine farms, creameries and farm product manufactories of the southeastern part of the state. This form of instruction has been applied to students of animal husbandry in previous years, but has never before been given to students of agriculture in general.

UNIVERSITY AND EDUCATIONAL NEWS

It is reported that Yale University will appropriate from $60,000 to $80,000 a year for the increase of salaries of professors.

Wesleyan University has been admitted to the Carnegie Foundation for the Advancement of Teaching.

Dr. Robert Kennedy Duncan, professor of industrial chemistry at the University of Kansas, has accepted a call to the University of Pittsburgh.

Charles H. Shattuck, Ph.D. (Chicago), has been appointed professor of forestry in the University of Idaho.

Dr. James F. Abbott has been promoted to a professorship of zoology in George Washington University.

At Cornell University promotions to full professorships have been made as follows: J. I. Hutchinson and Virgil Snyder, in mathematics; A. W. Browne, in chemistry; E. M. Chamot, in sanitary chemistry; E. H. Wood, in engineering, and H. D. Hess, in machine design.

Mr. Nathan C. Grimes, instructor at the University of Wisconsin, has been appointed professor of mathematics in the University of Arizona.

At Stanford University, Dr. E. C. Dickson has been appointed assistant professor of pathology and Mr. Thomas B. Hine, acting instructor in chemistry.

Miss Annie Louise MacLeod, of Nova Scotia, has been appointed resident research fellow in chemistry at Bryn Mawr College.

At Haverford College, Professor A. H. Wilson, of the Alabama Polytechnic Institute, has been appointed associate professor of mathematics, as successor to Professor W. H. Jackson, who returns to England.

Clinton R. Stauffer, Ph.D., instructor in geology at Western Reserve University, has been appointed assistant professor of geology in the School of Mining (Queen's University) at Kingston, Ontario.

Dr. E. J. Goddard, Linnean Macleay fellow in zoology, Sydney, has been appointed by the council of Stellenbosch College, South Africa, to the chair of zoology and geology in succession to Professor R. Broom.

DISCUSSION AND CORRESPONDENCE

THE LENGTH OF SERVICE PENSIONS OF THE CARNEGIE FOUNDATION

To the Editor of Science: So many errors have been put forth under the protection of anonymity, and this is deservedly in such disrepute, that the only excuse I can give for not signing my name to this note is the self-evident one that some of those to whom I refer might thereby be recognized.

I have read with interest the rather caustic criticisms on the change of the policy of the Carnegie Foundation with reference to voluntary retirement after twenty-five years of service, and must confess that some of these criticisms read to me, doubtless wrongly, as though they proceeded by some process of indirect inspiration from persons who had hoped to give up their teaching duties and that this disappointed hope had rendered them somewhat acid.

As a comparatively young man (38) whose twenty-five years of teaching and scientific work will not end for nine years more, may I give my opinion on the new ruling?

I regard the Carnegie Foundation as one of the most signally useful methods that could be devised to elevate the dignity and honor of the profession of teaching. I do not see how any teacher can fail to feel more assured as to his own future and that of his family as a result of these rather generous provisions. Very few of us save anything and it certainly gives one a sense of greater ease and freedom from worry to know that when those days come when one must perforce feel that advancing age renders impossible the old-time efficiency, provision has been made for the passing of the closing years of life in dignity and honorable independence; would that the provisions of the foundation could be extended to every teacher in state, church, city and country schools.

Why should any one *wish* to retire after

twenty-five years of service? If disabled or incapacitated the foundation makes such retirement a possibility, and doubtless a welcome one to some few to whom fate has been or may be unkind. But the average professor after twenty-five years of service is at his best as regards maturity, solid productive ability, and influence over youth through the poise and weight given by years and experience. Personally, I should hate to retire after twenty-five years of work, though I admit that the power thus to enjoy one's *otium cum dignitate* as a well-earned reward, and the possibility of doing just the work one likes best without hampering scholastic duties appeals strongly to universal human nature, and confess that it might conceivably appeal very strongly to me.

I know of several men, personally in one or two cases and by hearsay in other cases, who had hoped to take advantage of the twenty-five-year provision within a few years. As far as I know, they are all doing good and valuable work, are all in good health, are under fifty-five—in one case by a considerable margin—and I do not believe that they are worked too hard. All are thoroughly honorable, upright men, and are honest with themselves in believing that they are justified in trying to take advantage of this provision. Personally, and perhaps wrongly, I feel that their retirement at this time would be to some extent a misuse of the foundation, and amounts almost to a desertion of their post of duty. Were we in a Utopia where all, business men, mechanics, professors and scientists, could rest and play after reaching fifty, we as a world might be much happier. By "rest and play" I mean working hard at the work we love best. Till we reach that Atlantis, however, our thanks for the blessing of work as long as we can work.

Doubtless the men to whom I have referred will continue their productive work, though one had no definite plans other than retirement to his farm. Now I may not know all the circumstances which prompted these men to seek retirement after twenty-five years of service, but I can not feel that the purposes of the foundation would have been strictly adhered to should this be granted them. I can not feel that the withdrawal of the privilege of retirement after twenty-five years works any injustice; the error came in lack of foresight in announcing this provision at the start. We need vigorous, young, enthusiastic men, but the more respected, well-poised, experienced men between fifty and sixty-five *plus* we can keep on our faculties, the better for our institutions.

Z.

SCIENTIFIC BOOKS

The Gulick Hygiene Series. By LUTHER HALSEY GULICK. Book One: *Good Health.* By FRANCES GULICK JEWETT. List price 40 c. Book Two: *Emergencies.* By CHARLOTTE VETTER GULICK. List price 40 c. Book Three: *Town and City.* By FRANCES GULICK JEWETT. List price 50 c. Book Four: *The Body at Work.* By FRANCES GULICK JEWETT. List price 50 c. Book Five: *Control of Body and Mind.* By FRANCES GULICK JEWETT. List price 50 c. Boston, Ginn and Co.

The editor states the objects and general plan of these books as follows:

> The objects of this series of books on hygiene is to teach the fundamental facts of health in such a way that the teaching shall result in the formation of health habits by the children. . . . In order to maintain the interest and avoid the deadening effect of the annual review of identical subjects, I have endeavored to supply each year some distinctive and separate line of thought in hygienic directions. . . . The style of the series is rather that of the story than that of the text-book.
>
> In four respects we have attempted in this series to do what so far as we know, has not been attempted before. (1) We have endeavored to present to children a series of texts in which the central theme shall be hygiene. The current text books treat of physiology and anatomy primarily. . . . (2) It is the purpose of this series to treat each subject in a purely scientific as distinguished from a philosophical manner. . . . (3) We have presented a new point of view in each volume. . . . (4) These little volumes have been prepared with the same kind of utilization of original works as if they had been intended for adult scientific workers.

The volume entitled "Good Health" was written for the fourth grade. In this a general view is taken of the subject. Scarcely any anatomy and relatively little physiology are given, the main contents of the book consisting of concrete and interesting facts relating to pure air, tobacco, cleanliness, sleeping, eye-sight, alcohol, hearing, finger nails, hair, care of nose and teeth, and eating.

The second volume in the series, "Emergencies," approaches the subject of the formation of habits from the standpoint of the emergencies which come to children. The skin is discussed . . . from that [standpoint] of blisters and burns. The habits that it is desirable for children to form with reference to conduct during emergencies form the subject matter of the year. . . .

The volume "Town and City," which is prepared for the sixth year of school life, presents the subject of hygiene from the standpoint of the community, and habits of action which have a social bearing are discussed; . . . the results of overcrowding, clean streets, garbage, ashes and refuse, parks, playgrounds, public baths, water supply, preventable diseases, food inspection, epidemics, vaccination, tuberculosis, city health, alcohol, microbes and disease. These are all topics in which individual action is involved. In all of them the relation and special emphasis are with reference to the state. The book is thus made an agency for the formation of habits having a community bearing.

The fourth volume, "The Body at Work," which is intended for the seventh grade, covers somewhat in detail the subjects ordinarily covered in the standard physiologies, but emphasis is laid on the training of the body for efficiency. Thus much is said concerning the importance of good posture and how to secure it; how one trains the muscles of the body that they may be efficient, enduring and strong; the nature and character of useful exercise; how digestion is most efficiently carried on. . . .

The closing volume of the series relates directly to the establishment of habits themselves— "Control of Mind and Body." In this book is discussed with some detail how habits are formed, not so much as a theory but as an experience; how habits are broken, fatigue, the wholesome development of the brain and spinal cord, the freedom which well-ordered habits give to the person who has them, the nerve endings, their care, etc. The whole purpose of the book is to give the individual that information which is related to the establishment of wholesome habits, particularly wholesome habits which shall be effective in the control of conduct.

A careful examination of these books justifies the following characterization:

1. They are written in a clear, readable style that is attractive and likely to be interesting to children.

2. They represent a serial story rather than a series of elementary and more advanced presentations of the same material. Each book is a new book on a new subject (as compared to the preceding book).

3. The facts presented are drawn largely from the results of accepted scientific investigations. The authors have made painstaking use of recent authoritative, scientific literature (for example note the discussion of the structure and physiology of the brain, and Cannon's experiments on intestinal movements).

4. The general motive, as indicated in the prefaces, is of a high order. The authors aim at human efficiency. The acquisition and conservation of health is regarded as an indispensable means to that higher end.

5. These qualities combine to make this an exceptional series of books, appearing in marked contrast with the conventional school text with its stereotyped style, its repetitions of text and illustration, its philosophical origin and consequent scientific inaccuracy, its limited scope, and its narrow ideal.

Several minor criticisms may be advanced as follows:

1. Book one, "Good Health," would be more complete if it contained some reference to the care of the excretions.

The system of ventilation shown diagrammatically on page 28 is an approved plan. It is backed by some of our best authorities. It is only fair to say, however, that such systems rarely work.

2. Some of the treatment given in book two, "Emergencies," is too advanced for children of the fifth grade. It contains a good deal of treatment that should be administered only by persons of some maturity.

Poisonous antiseptics should not be trusted to irresponsible children. The chapters on foreign bodies in the eye, on bandaging, and on poisons and their treatment, contain methods of treatment which would be unsafe in the hands of children.

3. One would expect a discussion of the "typhoid fly" in book three, "Town and City." Investigations of the last few years indicate that the fly is a most important factor in community hygiene.

The investigations of Meylan on smoking which have appeared since this book was written seem to throw considerable doubt upon the method and conclusions of Dr. Seaver's work, which is so liberally quoted in this book. Many of our discussions of the injurious effects of tobacco and alcohol need the careful and painstaking supervision of a trained investigator. It is easy to make serious mistakes in drawing conclusions from experiments and observations which are not properly checked with controls, or in comparing effects when the causes are complex and diverse, and therefore not productive of effects that will permit legitimate comparisons.

4. Book four, "The Body at Work," emphasizes good posture. There can be no doubt concerning the evils that accompany marked spinal curvature or a marked flattening of the chest with a great rounding of the shoulders. But so far as I know, we have arrived at our conclusions relative to cause and effect in these conditions philosophically and not scientifically. In addition I must admit, no matter how it offends my esthetic taste, that I have seen very few perfectly straight backs and shoulders. Most men have a stoop, and nearly all of us show a spinal deviation.

It would appear on pages 29 and 30 that the cuts there given represent either smooth muscle fibers, or nucleated forms of lower animals. They are not the human striated variety which is there under discussion.

Page 31. The soleus and gastrocnemius muscles seem to have exchanged names—a very slight error and of no consequence.

THOMAS A. STOREY.
COLLEGE OF THE CITY OF NEW YORK

Agricultural Bacteriology. By Professor H. W. CONN, Wesleyan University.

The second edition of Conn's "Agricultural Bacteriology" has been materially reduced in volume and has been brought more within the compass of a text suitable to the needs of students in agricultural colleges. It rightly emphasizes the great importance of microbes to fermentative activities, as this type of organisms is of much moment in agricultural processes, both favorable and unfavorable.

While covering the ground on the whole in a thorough manner, the volume is marred, however, by a certain looseness of statement in some of its chapters that is a serious defect in a classroom text, and the book contains altogether too many typographical and textual errors for a second edition.

To cite a few: "Fermentation and decay (p. 26) are defined as progressive chemical changes taking place under the influence of organic substances (evidently organized substances is intended), which are present in small quantity in the fermenting mass."

Decay and putrefaction are characterized as decomposition of proteid matter, the distinction being that decay occurs in the presence of oxygen, while putrefaction takes place in its absence. It is, of course, well recognized that decay of carbonaceous matter occurs, and that meat and other proteids may also putrefy in contact with the air.

The nitrates in the soil are stated (p. 47) as ranging from 0.1–0.2 per cent. This figure accords more nearly with the total nitrogen content of the soil. "Nitrites are changed to nitrates by the addition of another atom of nitrogen" (p. 57), meaning, of course, oxygen.

Speaking of the *Azotobacter* type (p. 94) they are regarded as more vigorous than the aerobic type (*Clostridium*), meaning *anaerobic*. The bacteroids of legumes are repeatedly referred to (p. 99) as bacterioids. The bacteria concerned in manure production are all regarded as putrefying organisms (p. 109), while, of course, it is well recognized that

many of the organisms present in manure are not associated with the production of malodorous compounds.

Reference is made (p. 145) to *Bacterium acidi lactici* in some cases and then again to *Bacterium lactis acidi,* when evidently the same organism is meant. This is apt to confuse not only the beginner, but even the more advanced student.

Numerous typographical errors as misspelled words, "dropped" lines, etc., occur, but these are not so serious in a way, as they can readily be recognized, but textual errors as noted above are less easily perceived by the student.

Science should teach a student to be exact and definite, but when texts are placed before him that contain so many slips of the pen, it sets a standard that makes for inferior work.

H. L. RUSSELL

SPECIAL ARTICLES

NOTE ON THE CHROMOSOMES OF NEZARA. A CORRECTION AND ADDITION

IN my preceding accounts of the chromosomes in *Nezara hilaris* (1905–06) I described the idiochromosomes as being of equal size and failed to recognize a dimorphism of the spermatid-nuclei. I have recently discovered that this was an error; and it is one that I wish to correct in advance of a more detailed description because *Nezara* now stands as the original representative of that type of insects in which neither a dimorphism of the spermatozoa nor a quantitative difference of chromatin between the sexes can be seen.

That type was first based on the single case of *Nezara hilaris,* but I afterwards added to it the lygæid species *Oncopeltus fasciatus* on the strength of Montgomery's earlier observations on the male and my own unpublished ones on both sexes. I was led to reexamine *Nezara hilaris* because of the discovery that in the closely allied southern species *N. viridula* there is a typical and very unequal pair of idiochromosomes, which show the usual relation to sex. The reexamination, in comparison with *N. viridula,* proves that in my earlier account the idiochromosome pair was incorrectly identified, and that in *N. hilaris* there is in fact a slightly unequal pair of idiochromosomes. This is, however, not the smallest pair (which is common to the two species) as both Montgomery and I were led to believe from the size-relations seen in other forms, but one of the largest; and in the second division it does not lie in the outer ring, as the small one does (a very exceptional position for the idiochromosome pair, as I pointed out) but occupies the typical position at the center of the group. The inequality of this pair in *N. hilaris* may readily be overlooked, since it is but slightly marked—far less than in *N. viridula,* and perhaps even a little less than in *Mineus,* as heretofore described. Moreover, both idiochromosomes are more elongated than the other chromosomes and often of nearly the same diameter, but differ in length. In polar views, therefore, the inequality often can not be made out, though in side views it constantly appears. My former figure of such a view actually shows an inequality of this pair, but insufficiently, the smaller member being represented a little too long and thick. The inequality is often more marked than in the particular specimen there figured.

Nezara can, therefore, no longer stand as a representative of the "third type" recognized in my paper of 1906, and *Oncopeltus* must probably take its place. I say "probably" because the case of *Nezara* shows how readily a dimorphism of the spermatozoa may escape detection when only a slight size-difference between the idiochromosomes exists. Renewed studies upon *Oncopeltus* (a very favorable object) shows that a slight inequality of the idiochromosomes may in fact often be seen at every stage of the spermatogenesis, from the pre-synaptic period onward. Quite as often, however, they appear equal, and the size-variation appears to lie within the range of variability in the other chromosome-pairs. A final decision in regard to this species is reserved for a future more detailed account.

A second point of interest, formerly overlooked, is the existence in the second division

of both species of *Nezara* of a quadripartite chromosome, composed of two somewhat unequal components and having exactly the form of a butterfly with wide-spread wings. This element, always lying in the outer ring and in constant position with respect to the spindle-axis, divides equally into two double elements. Each spermatid-nucleus thus receives six single chromosomes (including one idiochromosome) and one double element; though the duality of the latter is often obscured in the later anaphases. This phenomenon may indicate that a change in the chromosome-number is in progress, the double element representing either the initial stages in the separation of one of the "autosomes" into two (as appears to have occurred in case of the X-chromosome of *Syromastes, Fitchia,* etc.) or the final stage of a fusion of two into one.

EDMUND B. WILSON

THE STRUCTURAL CHARACTERISTICS AND RELATIONS OF THE APODAL FISHES[1]

THE characteristics and relations of the Apodals (Apodes) have been involved in much uncertainty even to the present hour. Nevertheless, no order appears to be really more trenchantly differentiated when a sufficient number of skeletons is at hand. Their chief characteristics of ordinal value may be given as follows:

Order Apodes

The order of eels or apodals is composed of fishes with a skull specialized especially by its extension forwards and the coalescence of the ethmoid, vomer (and premaxillaries?) into one piece which projects and is clamped laterally and more or less backwards by the maxillaries, the fusion with the vomer (?) or loss of the premaxillaries, the slight development of the palatal and pterygoid systems, the junction of the parietal bones, the presence of a chain of suborbital bones, the single cotyloid condyle for the articulation of the vertebral column, the freedom and reduced development of the shoulder girdle (and in some the complete loss), the single coraco-scapular plate in which are ossified the hypercoracoid and hypocoracoid, the mesocoracoid being lost, the brain of the ordinary teleost type but with secondary olfactory lobes in front of the principal ones, the great development of the branchiostegal apparatus, and the development of a pneumatic duct between the air-bladder and alimentary canal, and the loss or abdominal position of the ventral fins. The species propagate in the sea and pass through a peculiar stage known as the *Leptocephalus* or *Atopichthys* form, a ribbon-like translucent condition from which develops a later eel-like stage.

All the known species have the familiar eel-like form in varying degrees, some being much stouter and others excessively elongated, but the form is not an ordinal character, although in this case to a large extent coordinated with such characters. The absence of ventrals which gave name to the order (Apodes) is falsified by extinct representatives of the family Anguillavidæ, although justified by all the living species.

Inasmuch as much difference of opinion has prevailed respecting the homologies of the supraoral dentigerous bones, and as silence respecting them might be interpreted as the result of ignorance or undue disregard of others, some explanation seems to be called for here. By many of the old anatomists, the upper lateral dentigerous bones were considered to be palatines, but that view, for the most part, has been long abandoned. Recent high authorities, however, have regarded the bones in question as not homologous for the Murænids compared with the rest of the Apodals. While the upper bones of the Anguillids and other platyschistous eels have been admitted to be maxillaries, the lateral dentigerous bones of the Murænids have been homologized with the palatines or pterygoids. In other words, according to one author, the Murænids have the "maxillaries absent, replaced by the palatopterygoid, the mouth bordered by the latter and the ethmo-vomer," according to another, by "the toothed ethmo-vomer and pterygoids." Such an interpretation implies that the dentigerous bones, so much

[1] Abstract of a communication to the National Academy of Sciences, April 21, 1910.

alike and so highly specialized, connected, too, in such an unusual way with the cranium, have developed from two extremely different sources; that (1) the usual dentigerous bones have retained in the platyschistous eels, the functions performed in other fishes but under a highly specialized form, while (2) they have been lost in the engyschistous eels and bones (palatopterygoid), which had been much reduced or atrophied in the others, have been highly developed in the same manner but at the expense of the dentigerous bones of the typical eels. No reason has been assigned for such interpretations but it is probable that the posterior connection with the cranium of the dentigerous bones of the Murænids was one cause. We are thus forced into one or other of the two forks of a dilemma: which is the more probable, (1) that bones of two very distinct and disconnected arches have been inversely developed at the expense of each other in a like highly specialized manner, or (2) that the vomer-ethmoid has projected in one type (Colocephals) more than in the others (Euchelycephals)? The latter alternative has been preferred by the present author.

As to the premaxillaries, they have been considered to have been lost by recent ichthyologists, but it is at least possible (or even probable) that they have been consolidated with the ethmo-vomer, as Peters and Jacoby contended.

The order, as now limited, is represented by two suborders, (1) the Enchelycephals, including most of the species, and (2) the Colocephales, including (so far as known) only the Murænids. The only near relations of the apodals are the Carencheli, known only by a single species, which is distinguished by the distinct premaxillaries, free nasals, etc.

The Lyomeri, which have been generally associated with the apodals, are extremely distant and *contrast* with them by the absence of most of the characters distinctive of the order.

THEO. GILL

THE PROPER RESTRICTION OF EUCYNOPOTAMUS

SOME time ago I proposed the name *Evermannella* to replace *Odontostomus*, as the latter was found to be preoccupied in mollusca. Since then, Dr. C. H. Eigenmann, overlooking my use of this name, again proposed *Evermannella* as a new genus of Characinæ. with *Cynopotamus biserialis* Garman as its type. Subsequently I renamed Dr. Eigenmann's genus *Eucynopotamus,* a fact he seems to have entirely neglected, as his later proposal of *Evermannolus* shows. Thus *Evermannolus* must be considered an exact synonym of *Eucynopotamus,* embracing the single species *E. biserialis.* The wrongly identified genus *Eucynopotamus* of Eigenmann may now be known as GALEOCHARAX gen. nom. nov. (type *Cynopotamus gulo* Cope), to embrace the species *G. magdalenæ, G. humeralis, G. gulo* and *G. knerii.*

HENRY W. FOWLER

ACADEMY OF NATURAL SCIENCES
OF PHILADELPHIA

THE AMERICAN PHYTOPATHOLOGICAL SOCIETY. II

The Mildew of Ginseng caused by Phytophthora Cactorum (Leb. & Cohn) Schroeter: Professor H. H. Whetzel, Cornell University. (Read by Mr. V. B. Stewart.)

The mildew has long been known to the ginseng growers of Japan. It is known as "Koshi-ore," meaning a "bending-at-the-loins," from the characteristic drooping of the leaflets at the end of the affected petiole.

The relation of *Phytophthora cactorum* to the disease was first discovered by Hori in 1904 as pointed out by Van Hook. He demonstrated the constant association of this well-known Phycomycete with the lesions on the ginseng. Van Hook discovered this disease in Ohio and New York in May, 1905. He reports the constant abundance of oospores of *P. cactorum* in the diseased stems. So far as can be determined from the literature on the subject, no inoculation experiments have even been made to definitely establish the causal relation of this parasite to this disease.

The writer has observed this disease on an occasional plant in ginseng gardens since 1906. An epidemic of it appeared in a large ginseng plantation in New York State in 1909, causing a loss of more than 20 per cent. in some beds. Microscopical examination of a large number of diseased plants showed the *Phytophthora* always present in great abundance.

A careful study was made of the morphology of the parasite and its relation to the host tissues. These studies showed much the same conditions as those reported by Hartig for this fungus on forest seedlings.

A series of careful inoculation experiments were made as follows: (*a*) with conidia from diseased plants to healthy ones, (*b*) with motile swarm spores in water to healthy plants, (*c*) with mycelium from pure cultures of the fungus to healthy plants.

In every case there was prompt infection, with the resulting lesions characteristic of the disease. Microscopical examination of the diseased portions showed the conidia and mycelium of *P. cactorum* in abundance.

Pure cultures of the fungus were obtained by peeling back the epidermis on diseased stems and transferring bits of diseased tissue to sterilized bean pods. Oospores are produced abundantly in cultures. The isolation of this fungus in pure culture has not heretofore been accomplished so far as the writer knows. It is therefore the third species of the genus *Phytophthora* to be brought under cultivation.

On the Relationship of certain Bacterial Soft-rots of Vegetables: Professor W. J. MORSE, Maine Agricultural Experiment Station, and Dr. H. A. HARDING, New York Agricultural Experiment Station.

The organisms studied include several named species of soft-rot bacteria, in addition to nearly forty other strains isolated during the progress of the investigation. They represent pathogens from various cultivated vegetables, and one each from the iris and calla lily, obtained from widely separated sections of Europe and the United States.

The data were accumulated in two different laboratories, extending over a period of several years, and the more important determinations were checked by four different workers. Some 12,000 subcultures were used and over 1,500 fermentation tube tests made, resulting in the conclusion that the organisms comprising the group are identical in all morphological, cultural, physical and biochemical features except in ability to ferment dextrose, lactose and saccharose.

An almost complete series of organisms was obtained, showing all except two of the possible combinations of fermentative ability from an organism which regularly produced visible gas in fermentation tubes containing any one of the three carbohydrates mentioned to one which never produced visible gas from either of them. While the final decision as to classification is reserved till work upon the pathogenicity of the various strains or described species is completed, the writers feel that based on the bacteriological studies alone the group should be considered as one somewhat variable species of which *Bacillus carotovorus* Jones is the earliest described and should therefore be considered as the type.

(Data to appear as Technical Bulletin 11 of the New York Experiment Station, and in the Twenty-first Annual Report of the Vermont Experiment Station.)

Timothy Rust in the United States: Mr. EDW. C. JOHNSON, Bureau of Plant Industry.

Timothy rust was reported in the United States by Trelease as early as 1882. Pammel reported it from Iowa in 1891. From 1891 to 1906 no mention of the parasite in the United States has been found. In 1906 the rust became epidemic in the timothy-breeding plats at the Arlington Experiment Farm, Virginia. Since then the rust has been common in many localities. It has been reported from all the states east of the Mississippi and north of Tennessee with the exception of the New England states, New Jersey and Illinois, and from Minnesota and Iowa.

The rust is similar in general appearance and morphological characteristics to *Puccinia graminis* Pers., on wheat. Its æcial stage is not definitely known in this country. Eriksson and Henning, working with a rust on timothy in Sweden, were able to produce æcia on barberries once in nine trials, and that only in one place of inoculation against 92 places inoculated with negative results. In trials in 1895 they again were unsuccessful in 25 inoculations on barberries. They concluded that the rust is a distinct species and named it *Puccinia Phlei-pratensis*. Kern considers it "a race of *Puccinia poculiformis* (*graminis*) or a so-called physiological species."

Inoculation experiments with timothy rust on various grasses in the greenhouses at Washington, D. C., demonstrate that the rust in the United States and the rust in Europe are identical, and that the species is not well fixed. The rust transfers easily to *Avena sativa*, *Secale cereale*, *Festuca elatior*, *Dactylis glomerata*, *Arrhenatherum elatius* and *Poa compressa*. Inoculations directly on *Triticum vulgare* and *Hordeum vulgare* give negative results.

Timothy plants brought into the greenhouse from Arlington Experiment Farm, Virginia, Jan-

uary 19 and March 12, 1908, began to produce fresh uredospores within six days after transplanting. In the field fresh rust pustules on new growth of timothy were common from March 13 on. Thus the rust mycelium is able to live through the winter in this locality. How the rust winters further north has not been determined. The teleuto stage is more common in Pennsylvania and New York than at the Arlington Experiment Farm, but as the æcial stage is perhaps rare in the United States the occurrence of teleutospores is of doubtful importance.

In timothy-breeding work at the Arlington Experiment Farm in 1908 and 1909, W. J. Morse, of the United States Department of Agriculture, found that the difference in varietal resistance of timothies to rust is well marked. This has also been determined in greenhouse experiments, and, although no variety or strain of timothy has been found to be entirely immune, there is a very noticeable difference in the degree of susceptibility of the different varieties to rust.

Floret Sterility of Wheats in the Southwest: Mr. Edw. C. Johnson, Bureau of Plant Industry.

Floret sterility of wheat, or the non-development of kernels in florets of otherwise normal spikelets, is common in the southwest, especially in parts of Texas and Oklahoma. The trouble has been variously attributed to insects, imperfect fungi, rusts and physiological conditions, but until recently no experiments have been performed to demonstrate what are the principal causes.

In 1908 and 1909 investigations were undertaken at San Antonio, Texas. There the per cent. of sterile florets in wheats was 30 to 50 per cent. and 12 to 15 per cent. for the two years, respectively. Although the exact rôle played by wheat thrips was not established, their importance as agents for spore dissemination was noticed. As many as five rust spores and three conidial spores of imperfect fungi were observed on the antennæ and appendages of a single thrip. As the thrips are exceedingly active and penetrate between the glumes of florets, spores are often carried into the young wheat flowers.

Ovaries of sterile florets were almost invariably affected with fungi. *Cladosporium graminum* Cda., and *Stemphylium* n. sp. were common on the leaves and diseased ovaries of affected grain and rusts, both *Puccinia graminis* Pers. and *Puccinia rubigo-vera* (D. C.) Wint., almost invariably were present in the florets. Inoculation of florets with spores of pure cultures of *Cladosporium graminum* Cda. and *Stemphylium* n. sp. were made by dropping a mixture of spores and water between the glumes held apart with tweezers. This increased the percentage of sterile florets. The increase amounted to three per cent. where 432 florets were inoculated with the former species and 195 florets similarly treated with sterile water were used for control, and 1.9 and 9.19 per cent., respectively, where 186 and 301 florets were inoculated with the latter, and 195 and 198 florets treated with sterile water were used for controls.

Similar inoculations with uredospores of *Puccinia graminis* increased the sterility 21.03 per cent. where 93 florets were inoculated and 206 florets were used for control. In two sets of inoculations where the wheat heads were soaked in water full of spores an increase of sterility of 7.36 per cent. and 6.08 per cent. resulted where 85 florets and 264 florets, respectively, were inoculated and 106 florets and 151 florets similarly treated with sterile water were used for controls.

No precautions were taken to prevent drying of the heads after inoculation, except covering both inoculated and control heads with tissue paper for two days. In the hot, clear days which followed the heads dried very quickly and the per cent. of infection was reduced. In an experiment where the wheat plants were screened from the direct rays of the sun an increase of sterility of 12.32 per cent. above that in adjacent unshaded control plants resulted. No artificial inoculation was performed. Shading prevented rapid drying in the mornings and thus gave better conditions for the development of fungi.

The experiments show that rusts and associated fungi, chief of which is *Stemphylium* n. sp., are undoubtedly the most important causes of floret sterility of wheats in the southwest. That similar conditions often exist in other localities was demonstrated at Minnesota in 1909. In the plats for rust resistance breeding all the grains when in bloom were sprayed with rust spores. In all the non-resistant wheats a large per cent. of the florets produced no kernels on account of rust infection in the heads, while in adjacent unsprayed plats such sterility was not marked.

Bacterial Blight of Mulberry: Dr. Erwin F. Smith, Department of Agriculture.

In 1890 Cuboni and Garbini studied a disease of the mulberry about Verona. This was ascribed to a *Diplococcus* believed to be identical with or akin to *Streptococcus bombycis*, supposed to be the cause of a disease of silk-worms. Successful

inoculations were claimed. In 1891–92 Macchiatti published papers on the disease, confirming the views of Cuboni and claiming successful inoculations. In 1894 Boyer and Lambert, in France, studied a blight of mulberries, obtained inoculations from cultures, and named the organism *Bacterium mori*, but did not describe it. In 1897 Peglion confirmed Macchiatti's views, obtained infections on leaves and shoots in three days' time, and stated the organism to be yellow and a liquefier of gelatin. Possibly he was working with mixed cultures.

In 1905 the writer made isolations from blighting mulberry leaves, and, influenced by the Italian work, paid attention only to such poured-plate colonies as were distinctly yellow. Two yellow forms were isolated and thorough inoculations were made on growing leaves and shoots of mulberries, but, contrary to expectation, no trace of infections was obtained. The diseased material came from Georgia.

In 1908 plates made from Georgia material showed the bulk of the bacteria in the freshly blighting stems to be a white species. With this white organism numerous successful infections were obtained on two varieties of mulberry, on both leaves and stems. With pure cultures plated from such blighting shoots, many additional infections were obtained. Independently at about the same time two of my co-workers obtained confirmatory results with the same white organism: (1) isolations and successful inoculations on the Pacific slope by Mr. P. J. O'Gara (oral communication); (2) isolations and successful inoculations in Arkansas by Mr. James Birch Rorer (oral communication). Typical-looking cultures were received from both men and with the Arkansas organism successful inoculations were made in a Department of Agriculture hothouse under my direction and also by Mr. Rorer himself. There is, therefore, no doubt whatever as to the infectious nature of the white organism. Whether the Italians who have secured infections inoculated with mixed cultures, one constituent of which was this white organism, or whether there is also a yellow organism (*Bacillus Cubonianus* Macch.) capable of causing a bacterial blight of mulberry, must be left an open question. If the latter supposition be true then *Cubonianus* is perhaps the proper specific name for the yellow organism.

Inasmuch as Boyer and Lambert obtained infections with their *Bacterium mori*, and have not made any incorrect statements respecting its character, I have adopted their name for the white organism, with the following emended characterization:

Bacterium mori B. & L. emend. Schizomycete causing a blight of leaves and young shoots of the mulberry. Spots at first water-soaked, then, sunken and black; foliage more or less distorted; shoots soon show sunken, black stripes and dead terminal portions. Action of disease rather prompt. In very young shoots all the tissues are involved—wood, pith and bark being infested by the bacteria. In older shoots the bacteria are confined mostly to the xylem and especially to the vessels, where tyloses are produced, as a result of the stimulus of the organism.

The organism is motile by means of a polar flagellum, sometimes two are present. It is actively motile when examined in a hanging drop made from a three-day agar culture. It occurs as single rods, pairs and short or long chains. The ends of the rod are rounded and the limits of size are 1.8 to $4.5\,\mu \times 0.9$ to $1.3\,\mu$. Most are $3.6\,\mu \times 1.2\,\mu$. No spores have been observed. Pseudozooglœæ occur, and involution forms were seen in beef-bouillon containing 6 per cent. sodium chloride. It stains readily with carbolfuchsin, but not by gram.

Colonies on + 15 Agar at 23° C.—White, slow-growing, round, smooth, flat, edge entire becoming undulate after some days, internal structure reticulate or striate.

Young Agar Streaks.—Growth moderate, spreading, flat, dull, smooth, becoming finely granular, translucent, slimy, odorless, white, medium not stained.

Agar Stabs.—Best growth at top.

Potato.—Growth moderate, spreading, flat, glistening, smooth, white to dirty white, slimy and medium grayed, only slight action on the starch.

Lœffler's Blood Serum.—Streak spreading, flat, glistening, smooth, white. No change in color of substratum or liquefaction (two months).

Surface Colonies on + 10 Nutrient Gelatin.—Flat, slow-growing, round to irregular, with lobate-erose margins.

Gelatin Stabs.—Best growth at top, line of stab filiform, no stain, no liquefaction.

Peptonized Beef-broth (+ 15).—Produces a pellicle, which breaks into fragments readily and sinks, forming a flocculent fluid; strong turbid clouding (clear after three months). Growth always best at the top, no distinct odor.

Milk.—Coagulation absent, fluid becomes clear

by destruction of the fat. After three months, and considerable evaporation, the fluid is more or less gelatinous and somewhat brownish (the ochraceous to ochraceous-buff of Ridgway, and near the ochroleucous of Saccardo). In such cultures there is always a small amount of pure white bacterial precipitate and the microscope shows entire absence of fat globules. Such milk is translucent, strongly alkaline and not viscid. At no time does the culture show any acid reaction or any striking reduction of litmus. Purple litmus milk blues promptly.

Cohn's Solution.—No growth, or very scanty.

Uschinsky's Solution.—Copious growth, not viscid, heavy fragile pellicle, sinking readily. Fluid bluish-fluorescent as early as the fifth to tenth day.

Sodium Chloride.—Tolerates 6.5 per cent. sodium chloride in + 15 peptonized beef-bouillon. It also grew twice in presence of 7 per cent. sodium chloride, but failed once when less copiously inoculated and did not grow in 9 per cent. sodium chloride bouillon.

Chloroform.—Grew unrestrainedly and for a long time in bouillon standing over chloroform.

Fermentation Tubes.—Does not produce gas or cloud closed arm in peptone water containing any of the following carbon compounds: dextrose, cane-sugar, milk-sugar, maltose, glycerine or mannit. Strongly aerobic.

Indol Production.—Absent or feeble.

Nitrites.—Nitrates not reduced to nitrites in beef-bouillon.

Temperature Relations.—Thermal death point about 51.5° C. Maximum temperature for growth about 35° C. Remains alive only a short time at this temperature. Minimum temperature for growth below 1° C.

Drying.—Rather resistant on cover-glasses—alive after 30 days, and another time after 50 days.

Sunlight.—Sensitive. Exposed in thin sowings in + 15 nutrient agar in Petri dishes bottom up on ice, one half of each plate covered, seventy per cent. were killed by 15 minutes' exposure, one hundred per cent. by 35 minutes' exposure, and ninety-five per cent. by 25 minutes' exposure. Colonies on the covered side developed freely.

The following are recommended as quick tests for differential purposes: Pitfield's flagella stain, peptonized beef-broth, Uschinsky's solution, Cohn's solution (5 days), litmus milk, nitrate bouillon, sodium chloride bouillon (5 per cent.), gelatin and agar plates; inoculation by needle-puncture into young rapidly growing shoots of susceptible species of Morus, which should show water-soaked spots in 7 days or less.

A New Spot Disease of Cauliflower: LUCIA MCCULLOCH. (Read by title.)

A New Tomato Disease of Economic Importance: Dr. ERWIN F. SMITH, Department of Agriculture.

In the summer of 1909 my attention was called to a stem disease of tomatoes prevalent in the vicinity of Grand Rapids, Mich. Microscopic examinations showed absence of fungi and great numbers of bacteria with considerable destruction of the inner tissues. Petri-dish poured-plates were made from these stems and the organism occurring in the plates proved to be a yellow schizomycete. Inoculations were made on July 27 in the open with material taken directly from the stems and shaken in bouillon, and the disease (gross appearance and histological phenomena) was in this way reproduced in a number of large tomato plants, progressing slowly, however. Poured-plates made from the interior of these plants demonstrated the presence of the same yellow organism in enormous numbers and another series of inoculations was made in October in one of our hothouses, using sub-cultures from typical colonies on these poured-plates. The results were the same as in case of the direct inoculations—all the plants contracted the disease, became stunted and were finally destroyed by it, but its progress was relatively slow, one or two leaves at a time slowly wilting or yellowing and shriveling; in other words, there is not that sudden collapse of the whole plant so characteristic of the southern bacterial disease of tomatoes (photographs were passed about showing various stages of this disease as obtained by pure culture inoculations).

The bacteria are very abundant in the vascular bundles, but the brown staining is less pronounced than in case of the disease due to *Bacterium solanacearum*.

The bacteria occur in the vascular system, but also hollow out cavities in pith and bark. The foliage is stunted and becomes yellowish, one leaf and one branch after another slowly succumbing to the disease. I am not sure whether the disease begins above ground or below. Whether the fruit itself shows the bacterial infection or not must also be left an open question. In the field, tomatoes from such plants were frequently brown spotted, but the origin of this brown spotting is still in some doubt.

[Since the above paragraph was written many of our check tomatoes in hothouses have contracted the disease, also much younger tomato plants on neighboring benches, together with a purple-flowered spiny Porto Rican weed (*Solanum globiferum?*) grown in the house because of its reported resistance to the brown rot. Not in a long time have we had such a wholesale escape of a bacterial disease to our check plants, and the indications are that the disease is readily communicated from plant to plant through the parts above ground, this being favored by liberation of the bacteria through the frequent cracking open of the diseased stems. We have also found the bacteria abundant in the fruits of diseased plants.]

The losses around Grand Rapids, Mich., last year amounted to eight or ten thousand dollars, and the writer has some evidence indicating that the disease is prevalent in other parts of the northern United States, and has probably hitherto been confused with the more rapidly acting disease due to *Bacterium solanacearum*. I suspect it to be a disease of hothouses as well as of the open.

Only some preliminary notes can be offered at the present time on the cultural characteristics of this organism, which may be known as *Bacterium (?) Michiganense*. Some of these characters are as follows:

The organism when taken from the vessels is a short rod with rounded ends, single or in pairs, termo-like; taken from ten-day agar culture and stained with carbol fuchsin, the majority are 0.35 to 0.4 × 0.8 to 1.0 μ. The writer observed no active self-motility when taken from the stem or old agar-cultures and examined in water. On staining young agar-cultures for flagella they appeared to be polar, but no good preparations were secured.

In morphology, as taken from the stem, the organism closely resembles *Bacterium solanacearum* as it occurs in the southeastern part of the United States. The organism from the stems came up rather slowly in + 15 agar-plates, the first colonies to appear being a few scattering intruders. Afterwards the right organism appeared plentifully in the form of pale yellow, smooth, wet-shining, round surface colonies not unlike those of *Bacterium campestre*. The buried colonies were small, round to broadly elliptical. The intruders in this case formed wrinkled, raised, gummy-looking, roundish yellow colonies.

Agar Stabs.—Surface growth in 15 days, at 25° C., 10 mm. in diameter, canary yellow, smooth, shining, opaque, flat, viscid. Stab growth finely saccate. Grows slowly on agar.

Corn-meal Agar Stabs.—Scanty, pale yellow surface growth. Moderate stab growth; better than in peptonized beef-agar.

Potato Cylinders.—After a month's growth moderate, spreading, thin, smooth, canary yellow; moderate amount of yellow precipitate in the liquid which is clear, *i. e.*, not thickened; potato slightly browned. This serves to distinguish the organism from *Bacterium campestre* and *Bacterium phaseoli*. The potato becomes alkaline to litmus paper. Only a small portion of the starch is destroyed.

Nitrate Bouillon.—Does not reduce nitrates to nitrites.

Cohn's Solution.—No growth.

Milk.—After fifteen days the surface of the milk is yellow (canary yellow to a depth of 3 to 4 mm.). There is also a yellow rim 2 to 3 mm. wide. In the lower part of the tube the milk was cream color, and was not solidified. The yellow layer on the surface increased in depth until at the end of a month it was 10 to 12 mm. in depth and yellow, the milk below having become a deep cream color, thick and smooth like butter. At this time there was some yellow precipitate at the bottom of the tube. In another set of test-tube cultures the milk at the end of fifty days showed a yellow translucent whey 12 to 25 mm. in depth, the curd being deep cream color. There is probably a lab ferment.

Litmus Milk.—The litmus is reduced. At the end of fifteen days the medium was uniformly pale gray (Saccardo's griseus) and liquid throughout. After a month the litmus color had nearly all disappeared, the milk being dirty cream color and somewhat thickened.

Beef Bouillon.—The appearance at the end of fifteen days was as follows: Moderate clouding, thin white flocculent masses suspended in the medium. A moderate slimy precipitate, which rises in long strings on whirling; these break with shaking, but do not readily dissolve. No rim or pellicle. After another three weeks, rolling clouds, densest at surface, wide patches of rim, no pellicle; precipitate moderate, yellowish, viscid, rises in a swirl on whirling. Organism grows slowly in + 15 bouillon.

Gelatin Stabs.—Growth after five weeks scant, canary yellow, surface smooth, shining, slight in the stab, no liquefaction (temperature 14° to 15° C.).

Very little is yet known respecting the methods of natural infection or the period of incubation. I am inclined to think, however, that the infection takes place several weeks before there is any general indication of the disease in the fields, and possibly dates from the time of transplanting.

Sulphur Injury to Potato Tubers: Mr. W. A. ORTON and Miss ETHEL C. FIELD, Bureau of Plant Industry.

This paper is the outgrowth of experiments conducted in California in 1909 for the control of potato scab. Among other substances flowers of sulphur was used in varying quantities to disinfect soils where the scab fungus was present. On digging the crop, many tubers from the sulphured rows showed sunken, dark spots from 5 to 30 mm. in diameter, which were relatively free from fungous or bacterial infection. These spots occurred only in tubers from sulphured rows. They were more numerous in the heavily sulphured plots, but were present even where the seed piece had merely been dipped in sulphur. Potatoes exposed to sulphur fumes in the laboratory developed similar depressed spots.

This injury has apparently not been observed in the sulphur experiments conducted in the east. The California soils are peat and in late fall became quite dry near the surface, so that volatilization of the sulphur could easily have occurred.

Outbreak of Potato Canker (Chrysophlyctis endobiotica Schilb.) in Newfoundland, and the Danger of its Introduction into the United States: Dr. H. T. GÜSSOW, Central Experimental Farm, Ottawa.

This well-known European potato disease has been recognized in specimens which I received from Red Island, Placentia Bay, N. F. The disease is due to a fungus of the order Chitridineæ and was named by its discoverer, Professor Schilbersky, in 1896, *Chrysophlyctis endobiotica*. The fungus attacks the tubers, but cases have been observed where the leaves closely above ground were also attacked. The changes due to the fungus on the tubers are very characteristic. Unfortunately the disease is not noticeable in the field until the crop is harvested, when it will be shown that the tubers are covered—according to the severity of the attack—either at the eyes only, or half or wholly by peculiar excrescences, not unlike the common crown galls of fruit trees. When a tuber is wholly covered with these excrescences they have lost all resemblance to potatoes and appear like irregular lumps of clay or coke. The fungus lives in the cells of these excrescences, which are not covered by the epidermis. It is present in these cells, first, as a more or less free plasmodium; second, as hyaline globular bodies, enclosed by a thick membrane and third, as yellowish brown resting spores very similar in appearance to those of the Peronosporæ. This latter stage is the most common one. The spores are very difficult to germinate artificially. Successful germination test showed that the spores burst and numerous swarm spores were liberated. These swarm spores infect new cells passing through the different stages—all of which are unsatisfactorily known—indeed it is doubtful whether there is any justification for the new generic name as described. The tubers decay by the action of the parasite and when harvested break to pieces and thus the soil becomes infected. The disease made its appearance in 1901 in England, is now present in Ireland, Scotland, Scandinavia, Germany and other European countries, but was not, until its discovery in Newfoundland, known on this side of the Atlantic. A visit to Newfoundland led to the discovery of the disease all over the neighborhood, and subsequently it was found to exist in other localities as well. As it was pointed out to me on inquiry that potatoes were imported in small quantities to the United States and Canada, great precaution is necessary to prevent the introduction and establishment of this serious pest. On account of the dangerous nature of the disease it was recommended that immediate action should be taken to safeguard the interest of the American and Canadian farmers, and a committee be appointed to consider the best means of dealing with the possible danger from its introduction into the United States. The fungus has also been referred to as *Œdomyces leproides* Trabut, but it is very different from this fungus, which according to Magnus is synonymous with *Synchytrium putæosam*.

Rhizoctonia Stem Rot of Beans: Mr. M. F. BARRUS, Cornell University.

While working on bean diseases in the vicinity of Oneida, N. Y., during the summer of 1909, quite a large percentage of plants were noticed to be affected with a disease which caused cankers on the parts of the stem below or at the surface of the ground, these lesions frequently encircling the stem, causing it to break over and resulting in the death of the plant. In some fields as much as 30 per cent. of the plants became thus affected.

During the following season at the same place the disease was found to be as prevalent as it was the year before. In some fields it caused the death of at least 5–6 per cent. of the seedlings, and, later in the season after a rainy spell, a large percentage of the pods in contact with the ground became infected.

When diseased stems or pods were placed in a moist chamber over night a fine moldy growth surrounded them. Direct cultures made from the stem gave a pure culture of a fungus, which, from the character of mycelium and the production of sclerotia, showed that it belonged to the form genus *Rhizoctonia*. Interesting studies were made of its growth on various media. Inoculation of healthy plants grown in sterile soil resulted in the production of lesions characteristic of the disease, upon the inoculated plants, the checks remaining healthy. Subsequently from these lesions the fungus was again isolated and the characters of its growth noted. Inoculations were also made on healthy pods, in every case resulting in a characteristic *Rhizoctonia* canker. No perfect stage has yet been observed.

The writer is carrying on further experiments with this organism and with a culture of *Corticium vagum* in an effort to discover whether they are identical. Professor H. R. Fulton, formerly of the Louisiana Agricultural Experiment Station, carried on a considerable number of infection experiments during the summer of 1907 with a *Rhizoctonia* which he isolated from the bean pod, and produced lesions on seedling beans and on injured pods.

Observations on Apple-tree Anthracnose: Professor H. S. Jackson, Oregon Agricultural College and Experiment Station. (Read by title.)

The Frog-eye Disease of Apple Leaves: Dr. John L. Sheldon, University of West Virginia.

The history, cause and present distribution of this destructive disease of apple foliage are referred to briefly. Several reasons are given why it seems preferable to use the name "frog-eye" for the disease of apple leaves caused by *Illosporium malifoliorum* instead of the name "brown-spot." (Specimens of the diseased leaves were shown.)

The Ohio Outbreak of Fusarium Blight of Potato in 1909: Professor A. D. Selby, Ohio Agricultural Experiment Station. (Read by title.)

On Mutualism in certain Parasitic Bacteria and Fungi: Mr. Thos. F. Manns, Ohio Agricultural Experiment Station.

In artificially demonstrating the production of disease, the writer believes that in the past too little recognition has been given to the organisms associated with the specific cause of the disease. It seems quite probable that the intensity of the disease, together with the varying symptoms, depends quite largely upon the parts played by others than the specific organism. In past experimental work on disease production, we have proceeded by determining the specific organism and eliminating all the associated organisms. The writer believes that in the future, if we are to know more concerning the progress of disease and the cause of its virulence, we must take into account the rôle played by the intimately associated organisms.

During the past two years the writer has been working upon the blade blight or "red leaf" of oats; a disease which experimentally is shown to be due to bacteria. In this work two bacteria were associated in the diseased blades. Inoculation work with each of the organisms separately showed that one was specific and capable of producing limited lesions in the oat blade, while the second organism produced no lesions at all; however, when both the organisms were inoculated together as a mixture the typical oat blight symptoms followed. After repeated demonstrations with similar results, it was concluded that we have in these two organisms a mutualism or symbiosis in the production of this disease. Platings from the inoculation of the two organisms in mixture showed the presence of both the organisms throughout the resulting lesions. The writer has described the specific organism as *Pseudomonas avenæ* n. sp. and the associated organism as *Bacillus avenæ* n. sp.

On artificial media considerable advantage was noted in the growth and virulence of the specific organism when grown with the associated organism.

The writer believes there exists similar relationships among fungi in the production of disease, however, in these cases, the associated organism may be only a semiparasite, following closely on the heels of the specific organism. It seems probable also that such relationships as the latter may exist between the specific fungus and certain bacteria.

Such relationship suggests itself as prevailing between the *Fusarium* of potato wilt and a certain *Vermicularia* which is so frequently associated in culture work upon potatoes infected internally

with the *Fusarium*. Through artificial culture work it was found that 62.8 per cent. of the tubers from a certain field was infected internally with the *Fusarium*, along with which was also the *Vermicularia* to an extent of 10.3 per cent. Culture work upon beginning lesions in the stem and roots usually brought out both of the fungi.

No experiments have been carried out to show whether both these organisms are actually taking part in the production of potato wilt, although such experiments are now under way.

On a Laboratory Method of Determining the Fungicidal Value of a Spray Mixture or Solution: Dr. Donald Reddick and Mr. Errett Wallace, New York State College of Agriculture.

The method consists essentially of spraying slides or cover-glasses with a spray substance of a given formula. After proper drying and exposure spores of the pathogen are placed on them in a drop of meteoric water to germinate. This method more nearly simulates natural conditions than that of using a drop of the spray substance direct. Experimental data in connection with the conidia of *Venturia inæqualis* have been obtained which confirm the fact.

Mycological Studies upon Wheat and Wheat Soils to Determine Possible Causes in Deterioration in Yield: Professor T. D. Beckwith, North Dakota Agricultural College and Experiment Station. (Read by Professor H. L. Bolley.)

Analysis of soil solutions made from old wheat soil and from virgin prairie soil did not show sufficient differences to warrant the assumption that deterioration in yield is due to lack of plant food.

Culture studies made from old wheat soil and from virgin prairie soil show that certain soil fungi belonging to genera known to be pathogenic to some of the gramineæ are present in the soil cropped for years to wheat. They are almost lacking in virgin soil, the probabilities being that they are wind sown.

These fungi belong to the genera *Colletotrichum*, *Fusarium*, *Macrosporium* and *Alternaria*.

In order to ascertain whether spores of certain of these fungi were normally to be found on wheat stems a series of four hundred germination tests were carried out by placing them in moist culture tubes. Examination was made microscopically after five days' incubation at 30° C. Following are the results showing the percentages of wheat infected by these fungi:

Nodes	
Colletotrichum	90.0
Macrosporium	65.0
Helminthosporium	62.5
Cephalothecium	10.5
Internodes	
Colletotrichum	83.0
Macrosporium	50.5
Helminthosporium	58.5
Cephalothecium	9.0

This preliminary series showed the possibilities for infection. The spores of these forms either were resting on the wheat plants or else had already germinated there.

The next series consisted of another four hundred nodes and internodes, but this time they were sterilized by treating one minute with one per cent. formaldehyde and afterward washing with sterile distilled water. Thus it is presumed that all saprophytes and surface fungi were eradicated. These stems were then allowed to germinate as in the former series. Microscopic examination showed the following per cent. infection by the fungous genera given below:

Nodes	
Colletotrichum	57.0
Macrosporium	53.5
Helminthosporium	40.5
Fusarium	33.5
Internodes	
Colletotrichum	52.5
Macrosporium	33.0
Helminthosporium	34.5
Fusarium	27.5

Finally culture experiments made from roots of wheat grown in old wheat soil showed the presence of *Colletotrichum*, *Fusarium* and *Macrosporium*.

These tests seem to prove (1) old wheat soil is infected with certain fungi, (2) the spores or mycelium of certain of these fungi are to be found normally in or on the wheat plant grown on such land, (3) a certain per cent. of the wheat is pathologically infected with certain of these fungi, (4) certain of these fungi cause root infection.

Peach Yellows and Frost Injury: Mr. M. B. Waite, U. S. Department of Agriculture. (Read by C. L. Shear.)

There seems to be some confusion about these two troubles of the peach. It is the writer's opinion that peach yellows has no relation what-

ever to winter injury. Peach yellows is thought by the writer to be a contagious disease, though the germ has never been discovered. It behaves in many ways, though not in all respects, like pear blight. For example, when the pear blight germ is absent from a locality there can be no blight no matter how favorable conditions may be. In the same way peach yellows has a distinct range in the northern and eastern part of the United States. It has increased its area rather rapidly. No matter what the conditions may be of soil, climate, method of culture, fertilizer, etc., when the yellows reaches a district it attacks the orchards.

Pear blight has its ups and downs. Some years the conditions are favorable and some years unfavorable for the spread of the disease. Peach yellows behaves in the same way. Pear blight spreads from colonies or infection centers. Peach yellows behaves in exactly the same way.

Pear blight lives over winter in the "hold-over" cases, this becoming the new infection centers each spring. With peach yellows every case is a hold-over till the tree dies.

Pear blight can be inoculated artificially by introducing the germ or the diseased tissues. Peach yellows can be inoculated by introducing a bit of living tissue. Both diseases are unknown elsewhere in the world, although their host plants are foreign to this country and are cultivated widely over the earth.

Pear blight was mistaken for frost injury before its bacterial nature was discovered.

We know peach yellows as a distinct disease, through a number of definite symptoms. The distinctive symptoms of peach yellows are, first, the premature, red-spotted fruit; second, wiry or bushy vertical sprouts of a peculiar character. Peach yellows has also certain leaf symptoms, such as yellowing and curling. These symptoms are also shared by the disease known as "little peach." The leaf symptoms, however, are not entirely reliable, as somewhat similar symptoms, often difficult to distinguish, are produced by winter injury to various parts of the trunk, collar and root, the peach borer, the root aphis, sour soil, chlorosis, or even nitrogen starvation or soil poverty.

Frost collar girdle may even produce slightly premature fruit as other girdling will do, but it is not typical, for the yellows and the symptom would not be reproduced in budding. True yellows is often mixed up in the same orchards with frost injury and other similar confusing symptoms. Oftentimes, however, through examination of doubtful trees there will be found other symptoms than yellows.

Frost injuries, particularly, since 1903 and 1904, occurred from Michigan to New York and New England in the yellows area. The eastern part of the frost injury area overlaps a district in which there has been an extensive outbreak of yellows. This district extends from New England, eastern and southern New York to Tennessee and North Carolina. Frost injury has been severe without accompanying yellows in western New York, Ohio and Michigan. Yellows has been severe without frost injury in New Jersey, Delaware, Maryland, southern Pennsylvania to Tennessee and North Carolina. The overlapping of these two troubles in southern New York and New England need not, therefore, be confusing.

C. L. SHEAR,
Secretary-Treasurer

SOCIETIES AND ACADEMIES

THE CHEMICAL SOCIETY OF WASHINGTON

THE 198th meeting and annual smoker was held at Fritz Reuters on Thursday, April 14. The attendance at the smoker, which consisted of a beefsteak dinner, was 57. The following papers were read at the meeting:

The Effect of Drugs and Diet upon the Thyroid: REID HUNT.

Dr. Hunt discussed the changes in resistance of animals to certain poisons caused by the administration of various iodine compounds. Evidence was presented that some of these changes are caused by an effect upon the thyroid gland and that certain iodine compounds have a selective action upon this gland, that, in other words, they are thyreotropic. Diet also was found to have marked effects upon resistance to certain poisons; some of these effects seem to be exerted, at least in part, through the thyroid gland.

Contribution to the Knowledge of Phosphoric Acid: B. HERSTEIN and LYMAN F. KEBLER.

Dr. Herstein said, in part, that a method having been found to determine each of the three hydrates of phosphorus pentoxid, when mixed with one another, commercial glacial phosphoric acid and metaphosphoric acid as prepared in the laboratory, were subjected to a study, the results of which showed that: (1) contrary to the hitherto accepted theory, metaphosphoric acid in changing to the ortho-form first becomes pyrophosphoric acid; (2) the percentage rate of inversion is very little, if at all, influenced by dilution.

Extensive tables and diagrams were prepared in support of the above.

Separation and Determination of Cocain and Strychnin, and Atropin and Strychnin when they Occur Together: H. C. Fuller.

Mr. Fuller explained that the alkaloids are extracted from the drug product and weighed together, using proper precautions to obtain them in a pure condition. They are then dissolved in alcoholic potash, transferred to a presure flask and heated over the steam bath for one hour, which completely hydrolyzes the cocain and atropin, but does not affect the strychnin. The latter is then separated and weighed.

J. A. LeClerc,
Secretary

THE AMERICAN MATHEMATICAL SOCIETY

The one hundred and forty-eighth regular meeting of the society was held at Columbia University on Saturday, April 30. The attendance at the two sessions included forty-two members. Ex-President W. F. Osgood occupied the chair at the morning session, Ex-President T. S. Fiske and Professor Frank Morley at the afternoon session. The council announced the election of the following persons to membership in the society: Mr. F. W. Beal, Princeton University; Professor W. J. Berry, Brooklyn Polytechnic Institute; Mr. J. K. Lamond, Yale University; Mr. R. M. Mathews, University High School, Chicago, Ill.; Professor F. E. Miller, Otterbein University; Mr. J. E. Rowe, Johns Hopkins University; Mr. W. H. Terrell, Clyde, N. C.; Mr. George Wentworth, Exeter, N. H.; Mr. W. A. Wilson, Yale University. Eight applications for membership in the society were received. The total membership is now 630.

Professor Maxime Bôcher was elected a member of the editorial board of the *Transactions*, to succeed Professor W. F. Osgood at the expiration of the latter's term of office. Professor L. E. Dickson was appointed to fill the unexpired term of Professor E. B. Van Vleck, who retires from the board in July.

The committee of publication was directed to publish in book form the lectures delivered at the Princeton Colloquium in September, 1909, by Professors G. A. Bliss and Edward Kasner. The Yale Colloquium lectures have just appeared from the press of Yale University.

The following papers were read at the April meeting:

H. B. Phillips: "Application of Gibbs's indeterminate product to the algebra of linear systems."

H. B. Phillips: "Concerning a class of surfaces associated with polygons on a quadric surface."

Virgil Snyder: "Conjugate line congruences contained in a bundle of quadric surfaces."

W. B. Carver: "Ideals of a quadratic number field in canonic form."

G. A. Miller: "On a method due to Galois."

E. H. Taylor: "On the transformation of the boundary in conformal mapping."

W. B. Fite: "Concerning the invariant points of commutative collineations."

R. G. D. Richardson: "On the saddle point in the theory of maxima and minima and in the calculus of variations."

H. H. Mitchell: "Note concerning the subgroups of the linear fractional group $LF(2, p^n)$."

H. H. Mitchell: "The subgroups of the linear group $LF(3, p^n)$."

C. L. E. Moore: "Some infinitesimal properties of five-parameter families of lines in space of four dimensions."

Edward Kasner: "Forces depending on the time, and a related transformation group."

F. H. Safford: "Sturm's method of integrating $dx/\sqrt{X} + dy/\sqrt{Y} = 0$."

G. F. Gundelfinger: "On the geometry of line elements in the plane with reference to osculating circles."

The Chicago Section of the society held its spring meeting at the University of Chicago, April 8–9. The summer meeting of the society will probably be held in New York City early in September.

F. N. Cole,
Secretary

THE AMERICAN CHEMICAL SOCIETY
RHODE ISLAND SECTION

The regular March meeting of the section was held March 31, 1910, at the University Club, preceded by the usual informal dinner. Professor William H. Kenerson, of the engineering department of Brown University, presented the paper for the evening on the subject, "Some Problems of the Testing Laboratory." The speaker showed by means of lantern slides the various types of testing machines and explained their method of operation and the results obtained. Then he took up some of the special problems that had been presented to the Brown Laboratory and showed the methods and machines devised to secure accurate results in the solving of these unusual cases.

Albert W. Claflin,
Secretary

Providence, R. I.

SCIENCE

FRIDAY, MAY 27, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

CONSTRUCTIVE COMMUNITY AND PERSONAL HYGIENE[1]

I. THE COMMUNITY

THE need of constructive work in medicine applies to the community as well as to the individual. The steady growth of American cities—in fact, of the cities of the world—indicates that we are to become in the not far distant future predominantly a city people. The accompanying diagram (*A*) shows how the rural population has been steadily falling and the urban population steadily rising since 1880 in all five census divisions of the United States. In Massachusetts, during the same period, there has been an absolute decrease of some thirty thousand in the rural population, while the urban population has increased by over one million. This is shown in graphic form in diagram *B*. The remarkable growth of the cities appears more graphically still in the diagram (*C*) showing the growth in the urban proportion of the population during the past eleven decades.

The causes of this steady urbanization of our kind are not far to seek. Three sets of causes may be read by him who runs. First is the *economic* cause. Owing to the use of machinery, an ever smaller fraction of our people can be engaged in the production of enough raw material to supply the needs of the world. To produce more than this is to invite economic disaster. Hence a progressively large fraction of the people will be engaged in

[1] An address delivered at the College of Physicians and Surgeons, New York City, April 14, 1909, in the course of Columbia University lectures on sanitary science and public health.

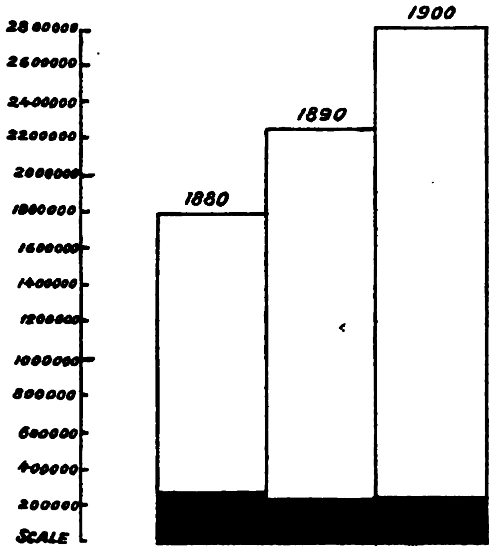

Fig. B. Urban and rural population in Massachusetts as shown by the censuses of 1880, 1890 and 1900. Urban population in outline and rural in black.

more rapid rate in urban communities than in rural districts.

Let us turn now from this statistical consideration to certain facts of general knowledge and observation which indicate

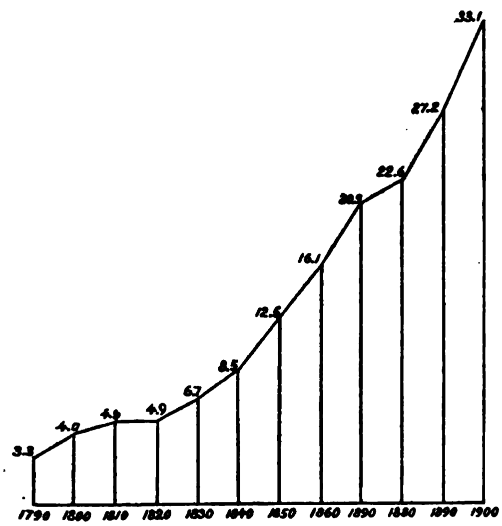

Fig. C. Diagram showing the increases in the per cent. of urban population in United States from 1790 to 1900.

not merely that we are gradually being forced to live together and are suffering thereby, but that we are learning to live together with increasing success and in some cases have already accomplished a result which places city life not only on a par with country life in healthfulness, but superior to it.

Water supply and sewage disposal are fundamental elements of wholesome living. In the very early days when the water supply was taken from pools or

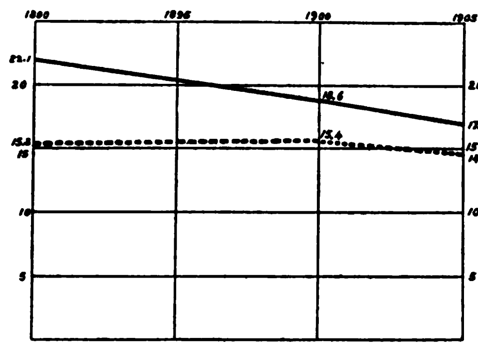

Fig. D. Diagram showing the death rates in registration states from 1890 to 1905. The solid line represents the urban rate and the dotted line the rural rate. Note that the death rate is falling much more rapidly in the cities than in the country.

running streams, and when human waste was either thrown on the land or into the water, it was necessary for families to live at considerable distances from each other if they were to be safe from disease; and even then there was a large degree of sickness in the individual family, due to the family waste. The location of privies in relation to wells has been so thoroughly exploited as to only need mention. Gradually we have come to live closer and closer together. To-day in our well-administered cities we have better conditions on the average than formerly obtained in the country, with respect to these two things. Our city water supply is safer than that of country districts, which is

drawn from streams and pools. This statement is true even when we compare the present city conditions with the country when it was sparsely settled and when the family lived quite by itself. The same is to be said in regard to the disposal of sewage. That is, these are purely mechanical problems which have been solved by our sanitary engineers. By using water from a good city water supply we are in less danger of contracting disease than in using country water; we are in less danger from the pollution and contagion resulting from sewage in the city than we are in the country.

This is not the only respect in which preventive medicine has been not merely remedying the evils of close dwelling together, but making them a positive good. It would take an extensive survey of widely connected groups of facts to show the relation of food supply in the city to the food supply on the old, isolated country farm. I do not think it is open to the danger of much serious criticism to say that the food supply available in our cities is more varied and better suited to support life and to make eating a pleasure, than it is in the country. The day of the all-round country farm has nearly disappeared. Those who come to the farms in summer find that the farms are to a considerable extent dependent upon the same sources of food supply as are the cities. It is not a fact that many of our farms have regular supplies of fresh vegetables to be consumed during the various seasons of the year. This is far less true in the city, where the food supply is made up of products drawn from various parts of the country and other parts of the world. By living together in communities we are able to have fresh meat regularly; this is rarely the case on the farm. I do not think it is too much to say that the milk supply of a modern, well-regulated city is better than the milk supply of the average farm where the dairy is unsupervised, the udders of the cattle unwashed, and the hands of the milkman in a not easily described condition. My own experience as a boy working on a farm and in a dairy forms the basis for some of these judgments. In regard, then, to milk, butter, eggs, meat, fresh vegetables and fish—those of us who live in cities are on the average better off than those who live in the country, who are largely dependent upon what they themselves raise. These, again, are largely problems of health, and the end of improvement is not yet in sight.

The chief objections made against the massing of people in cities, and indeed of city life itself, are that the city does away with privacy; that it creates dirt, darkness and bad ventilation in our dwellings; that recreation is unwholesome; and, in general, that the pace of life is too fast. The science of medicine has a profound bearing upon these problems. Let us consider first the problem of ventilation. The most extreme conditions of artificial ventilation are those which the submarine diver must face. Fresh air is forced to him. The air he breathes can be and is kept as fresh as that which is breathed by those who are in the open. It is true that people working out-of-doors in country districts breathe good air. It is very doubtful whether the habits of country people with reference to the ventilation of sleeping rooms are such as to give them any manifest advantage over the rest of us during sleeping hours. The problem of securing good air is purely a problem of sanitary engineering. It is not a problem of space. It is possible to so ventilate a room of any dimensions that it shall be entirely suitable as a place for working or sleeping. The tenement as such does not render it

necessary that the rooms shall be ill-ventilated. It is possible to have large numbers of small rooms, adequately and automatically ventilated. The air can be kept free from dust and at suitable temperatures, having at the same time the proper amount of humidity.

The problem of dirt is a similar one. The cleanliness of a room does not depend upon its size. The rooms of a tenement may be kept as clean as those in a well-administered office or even hospital building. It is a problem of adequate care, not a problem of congestion. Because a building is situated in the country is no evidence that it is cleaner than a building situated in the city.

The same problem presents itself regarding darkness. It is true that there are in the city many tenements with dark rooms. It is not true that this condition is necessary. Tenements with light rooms are now being built. We do not yet know to any full extent the character and effect of natural and artificial light upon human life. Important and interesting investigations have been made with reference to the effect of artificial light upon the growth of plants. We may discover that natural light is not necessary to any such extent as is at present believed. We do not know the possibilities even from the hygienic standpoint of indirect artificial lighting. The problem awaits the investigations of the sanitary engineer and physician.

The problem of privacy is the problem of the expensiveness of space in the city. Because we are dependent upon natural ventilation and natural lighting, and because we have in the main patterned our dwellings after those which evolved under conditions of rural life, all our feelings are to the effect that large rooms are better than small rooms. With the building of comparatively large rooms and the influx of larger numbers of inhabitants than was expected, there has developed the vicious habit of having a number of persons inhabit the same room. This condition can be partly met by the use of smaller rooms and forced ventilation.

The evolution of the city kitchen is one of the straws which shows the direction of present practise. Some years ago in building a house, the plan was altered so as to enable us to have a larger kitchen. We now see that this was due to a mistaken notion which has come down to us from the time when the kitchen was the center of the family life, when food was eaten in the place in which it was cooked, and the partaking of food together was a symbol of friendship. This larger kitchen proved a nuisance, for it involved too much walking from one part of the room to the other. The modern apartment house kitchen, which is exceedingly small, filled with space- and time-saving devices, is easily kept clean, is more convenient, permits more rapid operation, and is in every way better than the old style kitchen.

We do not yet know the feasible and even desirable limitations of space for various social and family uses. The disappearance of the trades from the home, the development of outside institutions as places for social life, and other changes have altered the basic space necessities of domestic life; but the traditions of the former conditions remain.

This whole group of problems needs to be attacked by the social worker who is equipped with the tools of sanitary science. The great work of constructive medicine or "biological engineering" consists not in the futile effort to turn back the hands of the clock which marks human progress, in the attempt to restore rural conditions, but in the study of the specific

conditions that are presented, in order that our cities may be more healthful abodes than human kind has as yet possessed.

Large steps in this direction have already been taken, quite aside from the fundamental ones of securing a varied food supply, good water and ventilation, adequate disposal of sewage; doing away with dirt and darkness, and the conserving of privacy, which have already been mentioned. We are awakening to the fact that there is a large group of elements in the situation which can only be attacked by the community as a whole. There are problems before which the individual family is helpless. I refer to such matters as the provision of adequate open air spaces for parks and playgrounds, places where wholesome social life may be carried on. We have already begun to realize that the average homes of our large cities are inadequate as social centers. We have watched with dismay the development of the saloon as a place where men may come together for social purposes; the dance hall, connected with the saloon, where young people come together and dance—a form of recreation which in itself is thoroughly wholesome, but which under prevailing conditions is a menace to both young men and young women. We need places where the children can play freely and in a wholesome way, without being imperilled by or hindering the traffic of the streets. We have in our municipalities ordinances against children playing in the streets, and this is right. We are commencing to take the steps which should go with the enactment of such laws, that is, steps for the provision of places where children can play. The open spaces are being increasingly built up or fenced in.

It was not many years ago that the city of Boston instituted its first public playground. In 1908 the state of Massachusetts passed a law which requires every city and town of ten thousand inhabitants and over to vote upon the question as to whether they shall have playgrounds purchased, equipped and maintained out of public taxes. Forty-two of these cities and towns voted during the following fall and winter. Of this number forty voted in the affirmative and two in the negative. The total vote cast in the affirmative was 154,495; the total vote in the negative was 33,886. Thus that state in the United States which is the least inclined perhaps of any toward socialism, which has had the most experience with playgrounds, has declared in a way that is almost unparalleled in the history of the referendum, that the city itself must provide not only places for children to play in, but competent leadership in those plays and games which shall make for wholesome physical and moral development.

Massachusetts does not stand alone. In 1907 there were ninety cities in America that were maintaining children's playgrounds supported at least partly by public taxation. The number has increased since that time, so that in 1909 there were upwards of 336, while over 118 additional communities are now taking steps toward the development of playgrounds or playground systems. The city of Philadelphia, not content with its exceedingly active but sporadic work, has recently appropriated five thousand dollars for a preliminary investigation as to the needs of the young people of the community concerning matters of recreation, and for the presentation of a policy and plan for the future development of recreation in the city. New York city, while it has not proceeded as far as to make any general plan for the development of the city and the provision for its needs, has already spent over eleven million dollars on children's play-

grounds, while Chicago has spent fifteen million dollars on a system of public playgrounds. I am told that the indirect expenditure upon these Chicago playgrounds runs upwards of forty millions.

These are all problems in community hygiene. Their initiative and direction depend upon the technical expert, who shall be trained in a way that is not yet possible in any school in America. The old forms of athletic exercise are no longer suited to the conditions of large schools with limited playgrounds. We need men who are trained with reference to the needs of the growing organism, who have intimate acquaintance with the nature of boys' instinct feelings, who will devise types and forms of athletics which will embrace the great mass of boys instead of the favored few that are brought forward under the conditions of interscholastic athletics which obtain at present.

The cities with their elaborate water supply are able to make provision for public baths in a way impossible in the country. Unlike the great European cities, the municipalities of the United States had done practically nothing for public baths before 1890. Since the agitation started at that time by Dr. Simon Baruch, a great deal has been done, though we are still far behind the other nations, owing in part to the common though quite erroneous impression that the majority of people have access to private baths. In 1904 the National Bureau of Labor published a comprehensive account of the public baths then existing in the United States, with a showing of thirty-seven municipalities, providing bathing facilities in a wide range of number and efficiency. There is no uniformity in the legal provision for baths. Massachusetts has had a permissive law since 1874, and New York a mandatory law since 1895, for cities of 50,000 and over. The control of the baths is variously exercised by the departments of public buildings, of parks, of education, etc. Though school baths are not compulsory, as in many European cities, they are a growing factor in the educational systems. The character of the baths provided is rapidly changing; the floating baths are becoming impracticable on account of the difficulty of keeping the water near large cities uncontaminated; tub baths are nearly out of use, while shower or rain baths are universal, being superior in cleanliness, ease of administration and economy. A few favored localities have swimming tanks. The baths are mostly free, though a few places charge for soap and towels.

As in our other public institutions, the psychological and social elements in the public baths are increasingly being recognized, so that with their growing attractiveness in form, there is also development in function. Thus in the latest buildings, gymnasiums, playgrounds and rest rooms are provided for comfort and recreation, while well-equipped laundries shorten the hours of labor for the women and at the same time form a natural social gathering place, like the old time village washing pool. The field houses of Chicago and other places give promise of meeting some such need as was met by the Greek palæstra and the Roman baths.

To mention a single instance, New York city at the present time has eight interior baths, and supports fifteen floating baths in summer. In 1902, a committee appointed by the Association for Improving the Condition of the Poor estimated that at least seventeen interior baths were needed in Manhattan alone. The eight baths now in operation vary in capacity and elaborateness from 154 showers and two large swimming tanks to eighty show-

ers. Two others are to be opened shortly and there is provision for four others. In 1908 the total attendance was 4,921,718, of which the Rivington and Centre Street baths counted 1,942,657, though the facilities there are less than in the others. There are a few schools provided with showers, and the Department of Parks maintains a few. Brooklyn has five interior baths and provision for two others, and seven floating baths. There are about a score of privately maintained free baths in New York and Brooklyn.

II. THE INDIVIDUAL

This need of constructive or preventive medicine as related to the community is no less important than its relation to the individual. It is not enough for the individual to have his disease cured, prevented, or even to render him immune. Something more is needed. Perhaps the case can be made clearer by an individual instance.

A young man, aged twenty-nine, came to a physician for advice. He had broken down from so-called "overwork." Successive visits to excellent sanitaria had put him on his feet temporarily, but when going back to his regular conditions of work and living, he again succumbed to them. A careful examination failed to indicate any particular pathological conditions demanding treatment, excepting those that are usually associated with consecutive fatigue. His heredity was excellent. The cardiac, pulmonary, digestive and excretory organs seemed to be normal, in both structure and function. Blood pressure was fair; the arteries were soft and elastic; reflexes were normal. But he was unable to think consecutively, or even to write a brief personal note, without producing mental confusion. In writing he was constantly obliged to refer to the first part of his sentence to see what he had said. In conversation he would frequently forget entirely all that had preceded and would have to be reminded of the subject. His history showed that his habits of work were injudicious. He had become so completely absorbed in his work as to keep it before him during meal times; he would take it home with him, carry it on Sundays and holidays. The problem consisted not merely or mainly in inducing him to take such steps as would lead to a recovery from the fatigue, but in discovering those habits of life under which he would work most effectively; in discovering what hours of labor would produce the best results; what kind and quantity of recreation, as well as intellectual interests, he should cultivate; and discovering how under his particular conditions it was possible for him to establish and maintain these habits.

A course of ordinary sanitarium treatment was established at first, his physician being daily, and at times almost constantly with him, for at this period it was not possible for him to develop sufficient initiative to carry out the details of his prescribed activities. He was given gentle, outdoor exercise for considerable and definite periods each day. His dietary was studied with reference to his own idiosyncrasies which were rather definite, but which up to that time were unknown to himself. As he recovered from his fatigue, he was given courses in reading, at first fifteen minutes twice a day. It was reading of a kind that involved definite attention and logical thought, but of a character wholly different from that required by his regular occupation. At the end of three months he was in a normal condition; but if he had been allowed to return to his work at that time, he would have been in the same condition as he had

been after previous experiences in sanitaria.

Consequently he was allowed to resume his professional work in progressive doses. At first he was allowed to work an hour per day. With increasing strength and adjustment the amount was steadily increased, until he was doing as much work per day as he had ever done, but was doing it in fewer hours. He had established other intellectual interests. He had learned how to play, had learned the fundamental necessity of attention to the essentials of good living, namely regular and wholesome eating, sleeping, exercise, etc. He was kept under observation for about six months. This happened eighteen years ago; he has carried his work successfully ever since.

This case is mentioned, not because it is exceptional, but because it is not exceptional. People do not know how to live. This man needed, as most people do need, the help of the physician—not only in times of disease, to aid in recovery, not only that they may be preserved from accident, contagion and other sources of disability. People need to be taught how to administer their time so as to live wholesomely and effectively, how to live so that life shall be a joy and not a burden, how to use their leisure time so that it may contribute to strength rather than to exhaustion through dissipation—how to manage efficiently the machinery of life. This is the problem of the biological engineer.

Let me mention another case. It is that of a man who died recently at the age of forty-seven. The immediate cause of death was cerebral hemorrhage, due to arterial sclerosis, with its usual degenerative conditions of the kidneys. There appeared to be no adequate reason for the loss of this man to himself, to his family, to his community, excepting that he did not know how to live. He was unwise in his eating, unwise in his manner of work. He did not know the significance of recreation, nor did he know the particular idiosyncrasies of his personal makeup.

We are told that every man is a fool or his own physician at forty. But the human organism is too complex to permit of adequate self-knowledge gained merely through common sense and personal experience. To this must be added that wisdom which can only come from the study of large numbers of cases and the putting together of extensive experiences. It is a conservative statement to say that the average efficiency and happiness of American men and women could be doubled by judicious attention to these matters of health. I do not mean merely the rigid observance of general rules of hygienic living. I mean specifically that conduct which is based upon an expert knowledge of the individual's peculiarities, and of the environment under which he is living and must work.

This study of individual differences, of individual environment, is one which gives scope to the largest powers and gives rewards of the highest character. We all know that it is foolish to tell the overworked bank clerk that he must take a vacation, go off to Florida or Europe for six months, when he is without financial resources. It is foolish to tell an engineer who is in the middle of a large piece of work that he must stop and take a vacation. It is necessary for him to complete his work. The problem is to find out how that particular man, with his particular makeup, under the particular environment in which he lives, may so conduct himself as to get the maximum of life, efficiency and happiness out of himself.

It is a problem of discovering the kind of habits that the individual ought to

form, of finding out how he can form those habits, and then standing by him until the habits are formed and the new life fairly on its way. It is not enough for us that we shall be protected from the contagion of smallpox, that we shall not be inoculated with the plague, that we shall not have our water supply contaminated with the typhoid bacillus. It is not enough even that the tissues of our bodies shall be highly resistant to various diseases. There is the great positive constructive side which relates to life's habits that needs attention, and without such attention the individual is helpless in securing for himself that high degree of efficiency which every skilled engineer demands from a good piece of machinery.

This phase of medical practise is gradually coming to be recognized by the laity and is being met by the profession. It is obvious that equipment for such practise involves, as does every other medical specialty, the classic studies of the regular medical curriculum. This specialty also, like every other specialty, demands its own kind of aptitude, as well as that specialization in study and experience which belongs to a specialty. It consists essentially in bringing medical science to bear upon the whole life of the patient, so that it may be raised and kept on the highest attainable level of efficiency and wholesomeness.

III. CONCLUSION

This is not the place to discuss other great problems that are incident to the life of the city or to that of the individual. I have tried merely to show that community life is of necessity increasing; that the conditions that are deleterious to health can be and are being met; that the prospect is already clearly in view that urban conditions will be more favorable to human life than rural conditions; that the desire of our kind to live in close relations can be gratified with a gain, instead of a loss of human life and vitality.

It is not enough that medical science shall be increasingly successful in combating and curing disease by means of drugs, surgery, suggestion and hygienic measures. It is not enough that the great sources of disease shall be eliminated by providing freedom from contagion and infection through uncontaminated water, pure food, fresh air. It is not enough that by means of these or other measures we shall be rendered immune to any or even all diseases. It is not enough that we look forward with firm confidence to the control of tuberculosis, and even pneumonia, cancer and arteriosclerosis.

The science of medicine needs and is developing groups of specialists who are raising the efficiency of individuals by discovering the precise ways in which those individuals, with their particular constitutions, may best live in their particular environment. There are also developing other groups that are solving the problems of how human kind shall live in the new and glorious era that we are so fast entering, the era of living together, the era of the city.

LUTHER HALSEY GULICK

THE RESEARCH LABORATORY OF PHYSICAL CHEMISTRY OF THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY

During the past year thirteen men, including four candidates for the Ph.D. degree, have been working in this laboratory upon researches in theoretical and physical chemistry.

One of the main lines of work is the continuation of the research upon the properties of salt solutions in relation to the Ionic Theory, which, with the view of developing that theory, has been carried on for a number of years under the direction of Professor A.

A. Noyes. The special subjects at present under investigation are: (1) the transference numbers of tri-ionic salts by Dr. K. G. Falk, with the purpose of determining whether intermediate ions, such as KSO_4^- or $PbNO_3^+$, exist in considerable quantity; (2) the electrical conductivity of mixtures of salts, by Mr. A. C. Melcher, Dr. W. C. Bray and Mr. F. L. Hunt, with the purpose of establishing the general law governing the ionization of salts; and (3) the solubility of salts in the presence of other salts, by Dr. W. D. Harkins, with the purpose of determining empirically the form of the law of solubility effect which must be substituted for the inexact mass-action form of that law. This line of research has again been aided on the financial side by a grant of $3,000 made to Professor A. A. Noyes by the Carnegie Institution of Washington.

Another of the main lines of research in the laboratory, which is being carried out by graduate students under the direction of Professor G. N. Lewis, is the experimental determination and computation of a system of values for the free energy of chemical substances analogous to the system of values for the total energy previously developed by thermochemical investigators. The problem is one of fundamental importance to the science of chemistry, since from the free-energy data for the substances the equilibrium of the chemical reactions in which they are involved can be computed. The special reactions now being studied in this direction are: (1) that between sulphur and water, producing sulphur dioxide and hydrogen sulphide, by Mr. Merle Randall; (2) that between nitric oxide, nitric acid and water, producing nitrous acids, by Mr. Arthur Edgar; and (3) that between chlorine gas and chlorine-ion in aqueous solution, which is being studied by electromotive force measurements by Mr. F. F. Rupert.

Dr. W. C. Bray has continued the studies of the equilibrium of some chemical reactions begun a few years ago in this laboratory by Mr. G. M. J. Mackay; namely of those between solid cuprous iodide, iodide and cupric iodide in solution, between potassium iodide and polyiodide in solution and between iodine and water.

During the past year articles describing theoretical studies upon the newly developed principle of relativity have been published by Professor G. N. Lewis and by Mr. R. C. Tolman; and an article upon the quantitative application of the theory of indicators to volumetric analysis has been prepared by Professor A. A. Noyes. An experimental study of indicators from this standpoint has been undertaken by Professor M. S. Sherrill.

SCIENTIFIC NOTES AND NEWS

PROFESSOR GEORGE DAVIDSON, of the University of California, eminent for his contributions to astronomy, geography, navigation and geodesy, celebrated, on May 9, his eighty-fifth birthday.

COMMANDER ROBERT E. PEARY lectured before the Imperial Geographical Society of Vienna, on May 18, and was presented with the gold medal of the society.

PROFESSOR WALTER NERNST, professor of physical chemistry at Berlin, has been elected an honorary member of the Manchester Literary and Philosophical Society.

IT is stated in *Nature* that the council of the Institution of Civil Engineers has made the following awards for papers during the session 1909–10: a Telford gold medal to Mr. C. M. Jacobs (New York); a Watt gold medal to Mr. J. D. Watson (Birmingham); a George Stephenson gold medal to Mr. D. A. Matheson (Glasgow); Telford premiums to Messrs. F. C. Buscarlet (Sunderland), A. Hunter (Glasgow), I. C. Barling (Tynemouth), J. Dalziel and J. Sayers (Derby), and J. Shaw (Birkenhead), and the Manby premium to the late Mr. C. W. Hodson (London).

ONE of the Carnegie research scholarships of the Iron and Steel Institute, London, has been awarded to Professor Paul Gorens, of the Royal Technical College, of Aix-la-Chapelle, for a study of the properties of cold-hardened iron and steel.

Professor J. S. Kingsley sails for Italy and the Zoological Congress on May 28. All matter intended for the *Journal of Morphology* should be sent direct to the Wistar Institute until his return in September.

From Oxford University Dr. G. C. Bourne, Linacre professor of comparative anatomy and Mr. E. S. Goodrich, fellow of Merton College, have been appointed representatives at the International Congress of Zoology.

The Academy of Natural Sciences of Philadelphia has appointed as delegates Dr. Richard A. K. Penrose and Dr. Edgar T. Wherry to represent it at the eleventh International Geological Congress and Dr. Henry Skinner to represent it at the first International Congress of Entomology.

We learn from *Nature* that Dr. and Mrs. Seligmann have returned from their first exploratory ethnological survey of the Anglo-Egyptian Sudan, to which they were appointed by the Anglo-Egyptian government. They studied the hitherto uninvestigated Nubas of southern Kordofan, and the Shilluks, Dinkas and Shir of the White Nile. A short time was spent between the White and Blue Niles, where a Neolithic site was discovered. Observations were made on the sociology and religion of various tribes, and some anthropometrical data were obtained, especially of the Nubas.

Professor John R. Allen, of the University of Michigan, has been given leave of absence to go to Constantinople and assist the president of Robert College in laying out a course in engineering and to install an electric lighting system for that college. Professor Allen expects to visit a number of European schools of engineering.

Dr. F. W. Andrewes will deliver the Croonian lectures before the Royal College of Physicians of London in June. The Harveian oration will be delivered by Dr. H. B. Donkin on October 18. The Bradshaw lecture by Dr. G. N. Pitt; the FitzPatrick lectures, on "The History of Medicine," by Sir T. Clifford Allbutt and the Horace Dobell lecture, by Dr. W. Bulloch, will be delivered in November.

Dr. Leon J. Cole, recently appointed to the chair of experimental breeding at the University of Wisconsin, has begun his work. He has made arrangements to conduct breeding operations with small birds and mammals, such as will reproduce rapidly and will be inexpensive to maintain. He will also begin the collection of data as to the heredity of characteristics in farm animals. Work with plants will be begun later.

It is proposed to add to the collection of portraits of deceased members of the American Philosophical Society, that of its first president, Thomas Hopkinson (1743).

A memorial service for Dr. Harold Taylor Ricketts, associate professor of pathology at the University of Chicago, who died of typhus fever in Mexico City on May 3, was held at the university in Leon Mandel Assembly Hall, on Sunday, May 15. His fatal illness was contracted as the direct result of an investigation of the disease which he had been pursuing for several months. President Henry Pratt Judson made an address on the work of Dr. Ricketts, and the essential facts of his life and death were given by Dr. Russell M. Wilder, who was associated with him in his work in Mexico. Dr. Ludvig Hektoen delivered an address on the personality of Dr. Ricketts and the nature and value of the work. Professor Charles Henderson spoke on the humanitarian aspects of Dr. Rickett's work and his death.

On convocation day on June 14 at the University of Chicago will be laid the cornerstone of the library building which is being erected as a memorial to the university's first president, William Rainey Harper. The address will be delivered by Mr. Clement Andrews, librarian of the Crerar Library of Chicago, formerly instructor in chemistry at the Massachusetts Institute of Technology.

The council of the Royal Astronomical Society has adopted the following address in memory of Sir William Huggins:

The council have learned with the deepest regret of the death of Sir William Huggins, and desire to record their sense of the great loss which the society itself and science in general have thus

sustained. As fellow of the society since 1854, as a member of the council since 1864, as secretary in 1867–72, as foreign secretary in 1873–75, as president in 1876–78, and as foreign secretary from 1883 to the present time, he rendered services of the greatest value to our society. His wide knowledge and sound judgment were ever at its disposal. But it is on the higher ground of his having been the pioneer in all those branches of research now termed astrophysics that he has the greatest claim to respect and admiration. The council, in requesting the president to convey their sympathy to Lady Huggins on her bereavement, desire him to say how much they have reason to be proud and thankful for the noble life's work of her husband, with whom she has actively collaborated for so many years.

DR. ZENCHALLO, medical officer of the International Sanitary Commission, has died of plague at Jeddah as the result of infection when examining rats.

STANISLAU CANNIZZARO, the eminent Italian chemist, professor in the University of Rome and a member of the Italian senate, died on May 10, at the age of eighty-four years.

MR. JAMES CANTLIE, hon. secretary of the Pellagra Commission, has received, as we learn from the London *Times*, the following telegram from Dr. Sambon, dated Rome, May 13: "The pellagra field commission has definitely proved that maize is not the cause of Pellagra. The parasitic conveyer is the *Simulium reptans*."

AN International Association of Colonial Agriculture was founded in 1905 at the close of the first International Congress of Tropical Agriculture, held in Paris in that year. The association has arranged to hold a second International Congress at Brussels on May 20–23.

THE Society for the Promotion of Engineering Education is to meet at the University of Wisconsin, June 23–25.

THE Royal College of Physicians of London announces that the next award of the Weber-Parkes prize of 150 guineas and a silver medal will be made in 1912, the subject of the essay to be "The Influence of Mixed and Secondary Infections upon Pulmonary Tuberculosis in Man, and the Measures, Preventive and Curative, for dealing with them."

AMERICAN students of *Characeæ* will be interested to learn that, through the purchase of the herbarium of L. J. Wahlstedt, the Field Museum of Natural History has rendered available to them a wealth of authenticated material in that family. The material comprises a large series of specimens that have been attested by Alex. Braun, Rabenhorst, Stizenberger, Norstedt, Wahlstedt and Allen. The total collection numbers 1,750 sheets.

THE United States Pharmacopœial Convention at its meeting held at the Hotel New Willard in Washington, D. C., May 10–13, elected the following officers: *President*, Dr. H. W. Wiley, of the Bureau of Chemistry, Washington, D. C.; *first vice-president*, Dr. N. S. Davis, of Illinois; *second vice-president*, Charles Caspari, Jr., of Maryland; *third vice-president*, O. T. Osborn, of Connecticut; *fourth vice-president*, Leo Eliel, of Indiana; *fifth vice-president*, W. A. Bastedo, of New York; *secretary*, M. G. Motter, of the District of Columbia; *assistant secretary*, Dr. Noble P. Barnes, of the District of Columbia; *treasurer*, S. L. Hilton, of the District of Columbia. The board of trustees, for the expenditures of the convention, was elected as follows: J. H. Beal, of Ohio; F. W. Meissner, of Indiana; W. J. Schieffelin, of New York; G. H. Simmons, of Illinois, and H. M. Whelpley, of Missouri. The committee on revision of the Pharmacopœia was elected as follows: J. P. Remington, H. Kraemer, C. Caspari, Jr., C. L. Diehl, J. O. Schlotterbeck, A. B. Lyons, H. C. Wood, Jr., J. M. Osborne, M. I. Wilbert, H. H. Rusby, Reid Hunt, A. R. L. Dohme, A. B. Stevens, G. M. Beringer, E. G. Eberle, L. E. Sayre, E. Kremers, W. A. Puckner, L. F. Kebler, C. S. N. Hallberg, C. H. La Wall, G. D. Rosengarten, V. Coblentz, J. W. Hatcher, J. M. Good, H. V. Arny, J. A. Koch, S. P. Sadtler, W. Bodemann, J. H. Long, O. Raubenheimer, C. E. Vanderkleed, T. Sollman, W. H. Nixon, J. C. F. Anderson, N. S. Davis, J. M. Francis, C. E. Caspari, R. H. True, W. N. Gregory, H. M. Gordin,

J. W. England, C. W. Edmunds, E. H. Bartley, G. W. Diekman, P. Marvel, W. Haines, W. G. Alpers, L. C. Hopp, Albert Plaut.

Dr. J. N. Rose, associate curator in the Division of Plants, U. S. National Museum, accompanied by P. S. Standley and Paul G. Russell, of his staff, has just returned from a collecting trip through southwestern United States and western Mexico. It has resulted in the adding of more than ten thousand specimens forming some three thousand numbers to the U. S. Herbarium. Dr. Rose's field work began at Big Springs, Texas, and extended as far west as Tucson, Arizona, whence he followed the West Coast Route of the Southern Pacific Railroad as far south as Acaponeta in Tepic. The collection includes various fiber, rubber and economic plants as well as numerous seeds of useful and ornamental vines and shrubs. Among the specimens obtained that were especially interesting, is a curious traveler's vine, which is a plant that furnishes an abundance of drinking water; a giant morning-glory forming a tree two feet in diameter; a strangling fig which is able to kill the largest tree in the forest; an ear-pod tree which has a fruit resembling the human ear—whence its name; a gourd tree which bears large fruit along its trunk; a silk-cotton tree covered with great balls of snow-white cotton; and a monkey rattlebox tree which is covered with large mallow-like fruit which explodes with a loud noise. Some rare palms, century plants and cacti that were collected were sent to Washington and are now on exhibition in one of the greenhouses of the Department of Agriculture. This expedition was conducted by the U. S. National Museum in association with the New York Botanical Garden and the Desert Laboratory of the Carnegie Institution of Washington.

Mrs. Mary M. Emery, of Cincinnati, O., has purchased a tract of wooded land in a residence district and has placed it under the charge of H. M. Benedict, associate professor of biology in the University of Cincinnati, for the purpose of establishing a "city bird reserve." The land will be fenced with a cat-proof fence, water, food and nesting materials will be provided and a test made of the possibility of bringing back the native birds to the city. It is hoped that the plan will prove so successful as to be copied in other communities. Now that the birds in the fields are protected by law and progress is being made in the establishment of breeding reserves for sea birds, the time seems ripe for the inauguration of a definite campaign to increase the bird life of our towns and cities. This first experimental reserve will be known as the "Mary Emery City Bird Reserve." Information regarding the details of fence construction, suitable locations, food and care, will be gladly given by the biological department of the University of Cincinnati to any who may contemplate the establishment of a "city bird reserve" in their own community.

The *British Geographical Journal* states that an expedition organized by Mr. Douglas Carruthers, in conjunction with Mr. J. H. Miller and Mr. M. P. Price, who are financing it, will leave England at the end of March for northwestern Mongolia. The chief object of the expedition is to explore zoologically, botanically, and, as far as possible, geographically, the basin of the upper Yenesei River. The journey out will be made through Russia and Siberia to Krasnoyarsk, and thence up the Yenesei to Minusinsk. Here the expedition will fit out, and, leaving Russian territory, pass over into Chinese Mongolia. The upper Yenesei and its tributaries are almost completely surrounded by high mountain ranges, which form a secluded basin. In this basin dwells a curious tribe, the Sayotes, who appear to be confined to this restricted area. On the completion of the work in the actual basin of the upper Yenesei, the expedition will pass through Dzungaria to Kulja, which will be reached some time in November. After this Mr. Carruthers and Mr. Miller hope to winter in the Tarim basin, and then to continue their explorations in the spring in the Chinese provinces of Kansu and Alashan. That there is much of interest to record about the tribes of this region is shown by the fact that it includes the original homes of the

Turkish and Finnish races. Zoologically, the Yenesei is important as being the line of demarcation between the faunas of eastern and western Siberia. And if the expedition is able to reach Alashan and neighboring regions, there will be valuable geographical work to be done and problems regarding the desiccation of central Asia to be solved.

UNIVERSITY AND EDUCATIONAL NEWS

BY the will of Isaac C. Wyman, of Salem, Mass., a graduate of Princeton College, who died on May 18, most of his estate is bequeathed to Princeton University, to be used in whole or in part for a graduate school. Mr. John M. Raymond, of Salem, Mass., and Professor Andrew F. West, dean of the Graduate School were named as trustees. The daily papers estimate the value of the bequest to be from $2,000,000 to $10,000,000.

THE Jefferson Medical College of Philadelphia, has received a gift of $60,000 from Mrs. Maria Gross Horwitz, daughter of the late Professor Samuel D. Gross, the eminent surgeon, to endow the "Samuel D. Gross Chair of Surgery."

ASSISTANT PROFESSOR J. G. JACK will conduct a Field Class at the Arnold Arboretum, Harvard University, on Saturdays during the spring and early summer, to assist those who wish to gain a more intimate knowledge of the native and foreign trees and shrubs which grow in New England.

DR. E. J. WILCZYNSKI, associate professor of mathematics in the University of Illinois, has accepted a similar position in the University of Chicago.

DR. J. W. YOUNG, assistant professor of mathematics in the University of Illinois, has been appointed head of the department of mathematics in the University of Kansas.

MR. EDWARD M. WELLISCH, of Cambridge University, has been appointed assistant professor of physics in Yale University.

THE following appointments have been made at the School of Mines of the University of Pittsburgh:

A. E. Ortmann, Ph.D., professor of physical geography.

P. E. Raymond, Ph.D., professor of invertebrate paleontology.

S. L. Goodale, A.M., E.M., assistant professor of metallurgy.

L. K. Acker, Jr., E.M., instructor in mineralogy and geology.

G. T. Haldeman, E.M., instructor in mining.

Earl Douglass, A.M., M.S., instructor in vertebrate paleontology.

H. B. Meller, instructor in mining.

Dr. A. B. Wallgren, lecturer on first aid to the injured.

Alexander Silverman, lecturer on glass manufacture.

W. F. Fischer, E.M., assistant in petrography.

N. L. Estabrook, assistant in mineralogy.

J. B. Keller, assistant in assaying.

The year has been extended to four terms of 12, 12, 11 and 10 weeks each, so that a student can complete his course by working any three of the terms each year. He may also complete his work and graduate in three years if he takes four terms a year. A student, as heretofore, in this school can substitute a year of practical work done under the school's direction for one year of the usual class and laboratory work, and in this way graduate in three years. Some thirty-five thousand dollars worth of material has been added to the equipment during the past year.

MR. C. L. BOULENGER, of King's College, Cambridge, has been appointed to the lectureship in zoology at Birmingham University rendered vacant by the resignation of Mr. Leonard Doncaster.

DISCUSSION AND CORRESPONDENCE

WEISMANNISM, A CRITICISM OF DIE SELEKTIONSTHEORIE[1]

A NEW publication from the pen of August Weismann naturally must excite curiosity among biologists, not so much with regard to possible new ideas and theories, but rather with reference to the question how far the author has corrected and modified his old views in order to do justice to the numerous

[1] "Die Selektionstheorie." Eine Untersuchung von August Weismann. Jena, 1909. 70 pages, 1 plate and 3 text figures.

and serious objections to them advanced by various adversaries.

The title of the present booklet might suggest that Weismann had the intention of doing something like this, for his conception of the principle of selection is one of his chief peculiarities, which has been most vigorously attacked. But perusing this book, we find that not the slightest attempt has been made to discuss seriously these objections. Here and there a feeble show is made, as if he had paid attention to them, but generally he discusses only minor points, and avoids the most essential criticisms, those which, when admitted as correct, would inflict the finishing blow to that particular type of evolution-theory known as *Weismannism*. And further, a peculiar feature of the present book is that in certain cases Weismann admits that his critics are right in a particular point, but that he nevertheless insists in maintaining his old position and his old views about this point. We occasionally have come across this way of arguing in informal discussions with persons belonging to the weaker sex, but never, as far as we can remember, in a scientific treatise which pretends to be serious.

The whole book is an eulogy on selection and its power to *create new things*. Weismann believes, if this is admitted, then there will be no difficulty whatever in understanding the origin of the whole organic world, and consequently also the origin of new species by natural selection will be clear. He claims that he stands, in maintaining this view, upon the original standpoint of Darwin. *But Darwin never said that new species are created by natural selection.* Indeed, there is the title of Darwin's book, "The Origin of Species by Means of Natural Selection," and it must be confessed that, reading the title alone, it might be interpreted this way. But there are some people who have a habit of looking more closely at things, books especially, and when they began to read Darwin's book, they found out that there is a distinction of two processes within the whole great process of evolution: the one is the *transformation of species*, that is to say, the change of *one* existing form of life into *one* other one, and the other is the *differentiation of species*, that is to say, the dividing of *one* existing form into *two* or *more* other ones. The latter process is strictly the *origin of new species*, or, as it has recently been called, the process of *speciation*.

For the first process, the transformation of species, Darwin introduces the three factors: *Variation, Inheritance* and *Natural Selection*,[2] and treats of them in the first five chapters. But incidentally he also discusses the second process, the origin of new species. He does this chiefly in the fourth chapter, where he talks of the divergence of character.[3] As the writer has shown elsewhere,[4] Darwin feels a little uneasy about this point. Nevertheless, he gives a tentative answer, and this is, that new species originate, if they are "enabled to seize on many and widely diversified places in the polity of nature,"[5] or, "if (they) become fitted for . . . different habits of life or conditions."[6] This is exactly what by subsequent writers has been called *separation, isolation, bionomic separation*, and for which possibly the best term is "*ecological segregation.*" And I hope by mentioning these words Weismann may recollect that they are intended to express something, and that they are supposed to have a definite place within the evolution-theory. In fact, the working out of this principle is the most essential improvement added by subsequent writers to Darwin's theory.

The above distinction between transformation of species (Umwandlung der Arten) and the origin of new species (Entstehung neuer Arten) has been exposed again and again, has been discussed at such a length that it has actually become tiresome to have to repeat it. Any child should be able to see the point. But Weismann evidently fails to do so. All his previous writings, and also the present book, are, with reference to the dis-

[2] See summary at end of chapter IV., p. 102 ("Origin of Species," American ed., 1884).

[3] *Ibid.*, p. 86.

[4] *Pr. Am. Phil. Soc.*, 35, 1896, p. 175 ff.

[5] "Origin of Species," p. 87.

[6] *Ibid.*, chapter VII., p. 169.

tinction of these two processes, a maze of confused ideas, and he most obstinately continues to transfer the factor of selection, which Darwin introduced for the first process, and to apply it to the second process (speciation). Of course, in the writings of Weismann it is hard to quote a passage where he does this clearly and unmistakably, since in this respect clearness is altogether lacking, but, in the present book, it is easily seen that he actually intends to apply the principle of selection to the formation of new species by his reference to the mutation theory of de Vries. Of course, de Vries makes the same fundamental mistake. The mutation theory, as should be evident to everybody, deals preeminently and emphatically with the question of speciation; at any rate, de Vries claims that it does, if he wants to explain the *origin of* NEW *species by mutation*, and consequently it can not at all come into conflict with Darwin's principle of selection, which is intended only as a factor in the transformation process. Nevertheless, Weismann (as well as de Vries) regards the mutation theory as opposed ("Einwurf," p. 7) to the selection theory! Any one who expresses views like these demonstrates only that the true Darwinian theory is not understood by him, and that he has not the slightest idea of what the meaning and significance of de Vries's experiments are. As has been demonstrated elsewhere,[7] de Vries himself did not understand the bearing of his experiments upon the evolution theory in general, and, consequently, made the most serious mistakes in their interpretation.

This misunderstanding of Darwin's theory explains why Weismann so stoutly maintains that selection may *create new things: he needs some explanation for the origin of new species.* But this idea of his has been criticized so often that he is forced to pay at least some attention to the attacks, and, indeed, he admits that selection can not do anything without the material, with which it is to work, being furnished by variation: a number of writers have called his attention to this, and have reminded him that, if this is so, it is not logical to say that natural selection, by killing the unfit variations, "creates" new ones, but that the word "preserves" should be used. This objection is absolutely well founded, as everybody will grant, and Weismann has been cornered by it so completely, that no other escape remains for him but to say that this objection is "nonsensical" (sinnlos, p. 81). Further comment is unnecessary.

In his treatment of the "Lamarckian principle" and the causes of variation, Weismann shows the same lack of understanding, or, if not, a rather vicious tendency to distort facts and ideas. The Lamarckian principle, in its widest sense, which is also accepted by Darwin, says that the variations which are transmitted to the offspring are *caused* by the environment. It is true, Lamarck himself discussed "chiefly" (hauptsaechlich) use and non-use of parts as cause of variation. But Weismann admits, by using the word "chiefly," that there *are* others, and he surely ought to know that Darwin and subsequent writers have enlarged this principle so as to regard all reactions of the body to environmental factors as variations in this sense (acquired characters). In the present booklet, however, Weismann restricts the Lamarckian principle strictly to "use and non-use," and then, of course, it is easy for him to show that in particular cases quoted by him the Lamarckian principle does not apply.[8]

His chief argument against the Lamarckian principle is that we are to entertain "strong doubts" (p. 6) against the cooperation of this principle, and that the transmission of acquired characters is "hard to

[7] See SCIENCE, 23, May 11, 1906, p. 746; 24, August 17, 1906, p. 214; 25, February 1, 1907, p. 185.

[8] *This is a beautiful illustration of Weismannian logic.* On page 6, line 10, he uses the word "chiefly" (hauptsaechlich) in this connection, while almost immediately below, on the bottom line of the same page, "functional" variations (by use and non-use) become the "only ones" (allein), which constitute the Lamarckian principle. This surely justifies what we have said above on his tendency to distort things.

imagine" (kaum vorstellbar). There is hardly a single paper of Weismann on evolutionary subjects which does not assure us of this. But the reviewer has not seen in any one of them a clear statement what these doubts are, and his personal power of imagination, which surely has the same convincing force as Weismann's, is entirely adequate to admit this theory. Weismann's opinion to the contrary and his idea of "germinal variation" is a working hypothesis pure and simple, and should be used only as such; but the two opposite views should never be used as evidence against each other, and this is what Weismann does again and again, also in the present book. *The Lamarckian principle is wrong, because it is in conflict with the Weismannian theory of the germ plasm, and the latter is correct, because, since the Lamarckian theory is wrong, it is the only way to explain evolution.* This is practically the essence of Weismann's argumentation: a schoolboy's blunder against logic.

On the other hand, Weismann purposely overlooks the recent experimental evidence for the inheritance of acquired characters, furnished now by quite a number of biologists. He knows, at any rate mentions, only two of them, Semon and Kammerer, and says that, according to Pfeffer, those of the first are "incorrect" (nicht richtig), and that he is going to show that those of the latter can not be regarded as convincing. The reviewer is much afraid that this latter demonstration will rest upon something like Weismann's argument, which intended to show that his own experiments on *Polyommatus* do not furnish support for the Lamarckian view. As to the latter, I beg to compare what I have said some time ago with regard to this matter,[9] to which I have to add nothing, and which clearly shows that Weismann's conception of the Lamarckian principle is entirely wrong, in fact that he does not at all understand what the essential point in it is.

We may summarize our conclusions as to the Weismannian theories and the Weismannism as follows: In the beginning, Weismann proposed his theory of the germinal variation, and the subsidiary theory of the all sufficiency of natural selection in opposition to the current view of the inheritance of acquired characters, without positive support, but chiefly on account of the supposed insufficiency of the latter view. At that time it was a working hypothesis as well as the other theory. In his subsequent writings Weismann tried to strengthen his position, but he was forced, first of all, to abandon his idea of the "amphimixis" as the cause of germinal variation, and further he introduced his theory of the "germ plasm" and its variation, and, in close connection with the latter, his theory of inheritance.

By the theory of the "variation of the germ plasm" he *changed his original views of "germinal variation" in a fundamental way,*[10] a fact which was never acknowledged by him, and further, in connection with this, he was forced to admit facts which are strongly in favor of the Lamarckian principle, which, however, he denied by the argument: *if Lamarckian inheritance can be explained by the germ-plasm theory, there is no Lamarckian inheritance.*

His special views on the principle of selection, although attacked repeatedly and disproved, in part as incorrect, in part as illogical, were always maintained and defended by him, but only at the risk and to the detriment of sound logic. At the present time, in the booklet reviewed here, he is upon the old standpoint; he has not considered valid objections to his views, and has passed over the most serious in silence, repeating again and again his old blunders and absurdities.

This has gone on too long. *Weismannism* has become a term characterizing not only a particular brand of Darwinism "made in Germany," but also a particular kind of loose and illogical reasoning, which we are not wont to regard as a product of German universities. This harsh criticism would not be necessary but for the fact that Weismannism has become a scientific "creed"

[9] See *Biol. Centralbl.*, 18, 1898, p. 153, and SCIENCE, 23, June 22, 1906, p. 950.

[10] See *Biol. Centralbl.*, 18, 1898, p. 139 ff.

among a certain class of biologists, and, in consequence, has delayed progress in biology for a considerable time. Weismann alone is responsible for the discredit into which the Lamarck-Darwinian view of the causes of variation has fallen: the latter has become unfashionable and "not up to date." Thus biologists were and are to a certain extent afraid of looking at evolutionary questions under the assumption that the "inheritance of acquired characters" might possibly be correct, and failed to do, what was most needed, to prove or disprove this view by the way of experiment. Fortunately, at the present time, conditions seem to improve: observations and experiments are being made which have a distinct bearing upon this question, and we may say that unexpected results are forthcoming which tend to show that the Lamarckian principle, which is also Darwin's view of the origin of transmissible variations, should be reckoned with. We only hope that this spirit of emancipation from a scientific dogma may prosper and flourish, and true progress will be assured.

A. E. ORTMANN

CARNEGIE MUSEUM,
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NOTE ON THE MARKING SYSTEM IN THE ASTRONOMICAL COURSE AT COLUMBIA COLLEGE, 1909-10

AFTER the first half year's work in the introductory astronomical course at Columbia had been finished, a test was made to ascertain the precision with which marks were assigned after the mid-year written examination. The answer books as handed in by the students were arranged in alphabetical order and each fifth book selected. In this way eleven answer books were obtained, representative of the class as a whole and chosen entirely without bias.

These eleven books were then marked by the following six professors of astronomy: Professor John M. Poor, of Dartmouth; Professor F. R. Moulton, of Chicago; Professor Wm. Beebe, of Yale; Professor O. M. Leland, of Cornell; Professor S. A. Mitchell, of Columbia; Professor Harold Jacoby, of Columbia.

No professor was permitted to see the marks assigned by the others; all were instructed to let the mark 10 represent that degree of proficiency which may be expected reasonably from a competent student who works hard; and 6 was to be considered a pass mark. No attention was to be paid to neatness, spelling, etc.; the marks were to be assigned upon astronomical proficiency only. The following table contains the results, the names of the professors being replaced by letters of the alphabet so as not to make public which professors gave the highest or the lowest marks.

Book No.	A	B	C	D	E	F
1	9	9.0	8.5	7.2	9	7.3
2	7	6.6	7.0	5.9	6	6.5
3	9	9.0	8.8	7.2	8	8.0
4	10	9.4	9.9	8.0	10	9.2
5	7	6.2	6.7	5.8	7	5.9
6	10	9.8	9.6	7.6	10	9.5
7	6	5.8	6.3	4.6	7	5.4
8	9	9.3	9.7	8.0	9	8.8
9	8	5.7	9.0	6.7	10	8.7
10	10	8.5	9.1	6.2	9	9.0
11	9	9.0	9.5	6.1	8	9.0
Average	8.5	8.3	8.6	6.7	8.5	7.9

The professor in the column D, whose average mark is 6.7, appears to have taken 5 instead of 6 as his pass mark; he explained in a letter that only one of the students should fail to pass in his opinion, although he assigned three marks under 6.

Making due allowance for this circumstance in the case of professor D, there is a very close accord in the marks given by the various professors. It would appear that the students have attained a very high average in their work, and that the marking system is more precise than some of its critics would have us believe. Possibly this may be due to the fact that astronomy is an exact science.

For the information of other teachers, the examination paper is appended.

HAROLD JACOBY

COLUMBIA UNIVERSITY,
April, 1910

COLUMBIA COLLEGE

MID-YEAR EXAMINATION, FEBRUARY 3, 1910

Astronomy 1

Answer three questions only in each numbered group

1, *a*. Define: celestial sphere, declination, hour-angle.

1, *b*. Describe the ecliptic circle and explain why we always see the sun in that circle.

1, *c*. What visible phenomena are produced by the earth's axial rotation?

1, *d*. Prove that the altitude of the celestial pole is everywhere equal to the latitude.

2, *a*. Explain sidereal and solar time.

2, *b*. Why does the vernal equinox occur on or about March 21?

2, *c*. Explain the reason for time-differences between different places on the earth.

2, *d*. In an ordinary horizontal sundial, what is the angle of elevation of the gnomon, and why?

3, *a*. If a small round steel ball is dropped from a tower, will it reach the earth at a point directly under the point from which the ball was allowed to fall?

3, *b*. If not, where will it reach the earth, and why?

3, *c*. How is the length of the earth's radius determined?

3, *d*. What is the "torsional constant" and how is it determined for any given torsion balance?

4, *a*. Why is summer hotter than winter?

4, *b*. In the northern hemisphere, is summer longer or shorter than winter? Why?

4, *c*. Explain tropical and sidereal years.

4, *d*. Explain the supposed relation between the age of the Great Pyramid in Egypt and the precession of the equinoxes.

5, *a*. Explain the aberration of light.

5, *b*. What are the four constituent parts of a date?

5, *c*. What is the leap-year rule in the Gregorian calendar?

5, *d*. How does the apparent angular velocity of the moon on the sky compare with the sun's, and why?

6, *a*. How is the moon's distance from the earth ascertained.

6, *b*. Explain two lunar librations.

6, *c*. What are occultations, and how are they used to determine terrestrial longitudes?

6, *d*. Demonstrate Kepler's law of areas under the action of a central force.

7, *a*. Define sidereal period of a planet, Synodic period of a planet, Conjunction.

7, *b*. Derive formula for computing the sidereal period from the synodic period.

7, *c*. Explain the connection between the visibility of a planet and its synodic motion.

7, *d*. Why does the synodic period approach 365 days as a limit for the outermost planets of the solar system?

THE DEFINITION OF FORCE

TO THE EDITOR OF SCIENCE: Professor Henry Crew, in his presidential address before the American Physical Society,[1] comments unfavorably on the definition of force given by me in a letter in SCIENCE of December 24, 1909, viz., "Force is a pull or a push, something that causes or tends to cause either motion or a change in the velocity or direction of motion." He expresses a "fear" that this definition is used by "not a few students of physics."

An elaboration of the definition, given many years ago by Professor I. P. Church, is as follows:

A force should always mean the pull, pressure, rub, attraction (or repulsion) of one body upon another, and always implies the existence of a simultaneous equal and opposite force exerted by that other body upon the first body, *i. e.*, the *reaction*. In no case should we call anything a force unless we can conceive of it as capable of measurement by a spring balance, and are able to say from what body it comes.

That "a few students of physics" use this definition ought not to be the cause of "fear" to any professor of physics; on the contrary, it should be a source of gratification. It is safe to say that nine tenths of all those students of physics who have occasion after their college days to make use of their physics are going to be either engineers or mechanics, and in that case they will have to learn this "standard definition of the engineer." It is well for them to learn it while they are young.

Professor Crew gives as "the one perfectly *correct, competent* and *complete* description of force" the "rate of change of momentum," and he credits Galileo and Newton with having thus defined it. I can not find, however, in the quotations he gives from Galileo and

[1] SCIENCE, April 8.

Newton any suggestion of such a definition. Galileo, according to the extract quoted, said that "the properties of accelerated motion are defined, without consideration of their causes, in such a way that the momentum (of the body) increases uniformly from the initial condition of rest in simple proportionality to the time," but this is a very different thing from a denial that force causes motion, or from an assertion that force *is* the rate of change of momentum.

Newton's second law of motion, according to one of the translations, is: "If a body be acted on by several forces it will obey each as though the others did not exist, and this whether the body be at rest or in motion." It would be difficult to explain this law if we substitute for the word "forces" the words "rates of change of momentum," especially if the body is at rest and therefore has no momentum.

Referring to the example of the action of force given in my former letter in SCIENCE, a stone is suspended from a projecting shelf by an elastic cord. The earth's gravitation acts on the stone. There is a tension and an elastic resistance in the cord. The word force is used as a generic term to include all those varieties of force that are designated by the words gravitation, tension, resistance, stress, etc. As long as the cord sustains the stone these several forces act, but as there is no motion there is no momentum, nor rate of change of momentum, which Professor Crew says force "is."

Let the cord break. We now have motion, which is change of position during time; velocity, ds/dt; momentum and constant acceleration; all so long as the stone is falling freely, and we may write the equations:

$$FT = MV; \quad F = MV/T; \quad F = MA; \quad V = 2S/T.$$

Before the cord breaks we have two elementary concepts to deal with, matter and force. After the cord breaks, and while the stone is falling, we have two other elementary concepts, space and time, and a few complex concepts: velocity, $V = 2S/T$ or ds/dt, momentum, $W/g \times V$, and acceleration, $(V_2 - V_1)/T$. It is only by a somewhat complex mathematical deduction that we arrive at the "pure concept of the intellect, but a precious concept," $F = (MV_2 - MV_1) \div T$, which Professor Crew says is a "perfectly correct, competent and complete description of force." A boy twelve years old easily grasps the concept that the force acting on the stone is the pull that tends to break the cord, and while he does not know what force is except by its effects, he easily conceives that it is the cause of motion when the cord breaks; it takes a metaphysician to arrive at the definition that force *is* the time rate of the change of momentum.

Let us return to the equations. In order to make them true we must choose certain units for each quantity. Some writers on physics say that the unit of mass is 1 lb. and that the unit of force is a poundal. Others say that the unit of mass is 32.2 lb. and the unit of force 1 lb.; still others that the unit of weight (quantity of matter, W) is 1 lb. and that M is merely an expression to signify W/g. One book on high-school physics defines mass as the quantity of matter, and gives its unit as 1 lb., and also gives the unit of weight (resultant of the attraction of gravitation) as 1 lb., and later gives the equation $W = Mg$, which is wrong if the definitions of the units are right, for in that case $W = Mg$ becomes $1 = 1 \times 32.2$. In the C.G.S. system there is no such trouble, for in it there are four different units to represent the four elementary quantities, viz.: dyne, gramme, centimeter, second. It is only when we try to graft the so-called absolute system on the English system, with its pound representing both quantity of matter and force, and invent new terms, such as the poundal and the gee-pound, to get over the difficulty which exists in the minds of the metaphysical physicists (but not in the minds of engineers, to whom $M = W/g$), that confusion begins.

The equation $F = (MV_2 - MV_1) \div T$ may be interpreted as follows: When a force F acts during a time T on a body which is free to move, and whose mass (W/g) is M, and gives the body an increase of velocity from V_1 to V_2 during that time, then if the units

of the several quantities are chosen so as to make the equation true, the amount of the force is numerically equal to $(MV_2 - MV_1) \div T$, or to the rate of change of momentum.

Let $T = 1$ second, $V_1 = 0$, $V_2 = 32.2$, $W = 1$ lb., $M = 1/32.2$, then the equation reduces to $1 = 1/32.2 \times 32.2$, or force = mass $\times$ acceleration, and it is correct, but if the unit of M is taken as 1 lb. then we have $1 = 1 \times 32.2$, which is incorrect.

The "correct, competent and complete" definition that force *is* the rate of change of momentum, no doubt is a metaphysical deduction from the formula, but it is neither correct, competent nor complete, and is not a definition at all. It assumes that we can translate the sign of equality (=), which really means "is numerically equal to" by the word "is." It is not true even as to equality except under certain limited conditions, viz., 1, that the units have certain values, such as $M =$ lbs. $\div g$, and 2, that the body is free to move. It is not true when a force is applied to a body not free to move, nor when a force is being applied to cause a body to move at a constant speed against a constant resistance, as when a canal boat is being towed, nor when a force is applied to a body moving with increasing speed with decreasing acceleration, as when an engine is bringing a train up to full speed.

"The debt that physics owes to metaphysics" is a sound castigation, for having introduced into physics such bad logic as that of making "equals" equivalent to "is," "darkening counsel with words," and substituting metaphysical deductions and complex concepts for simple definitions and concepts; and for introducing ideas that are so far from being "clear, sharp and definite" that they have to be unlearned or forgotten before the student can make satisfactory progress in engineering mechanics, and that they are discouraging even the high-school physics teachers themselves from teaching elementary dynamics, as was shown in Professor Edwin Hall's paper in Science of October 29, 1909. What is needed is a return to the good old definitions of Weisbach and Rankine, and a dropping of the metaphysical reasoning which has recently become the fashion.

Wm. Kent

Montclair, N. J.,

April 26, 1910

SCIENTIFIC BOOKS

SCIENTIFIC RESULTS OF SHACKLETON'S SOUTH POLAR EXPEDITION

The Heart of the Antarctic: Being the Story of the British Antarctic Expedition, 1907–1909. By E. H. Shackleton, C.V.O. With an Introduction by Hugh Robert Mill, D.Sc. *An Account of the First Journey to the South Magnetic Pole.* By Professor T. W. Edgeworth David, F.R.S. 2 vols., ill., plates. Philadelphia, J. B. Lippincott Co. 1909. $10 net.

It rarely falls to the lot of any single explorer to conjointly arouse such popular interest and contribute such important scientific knowledge as has been done by Sir Ernest H. Shackleton through his Antarctic expedition of 1907–1909. It should be realized that the inception, financeering, organization and successful administration of the expedition are due to Shackleton, it being a private venture unaided, and it may be also said unhampered by governmental offices.

Shackleton played an active part in Scott's Antarctic expedition, 1901–1903—when he was one of the four men who made a world's record of the farthest south—from which he was later invalided on account of scurvy. His early experiences were fruitful factors in his recent successes, which were in a measure due to improved conditions of food, clothing, shelter, transportation and travel methods.

Sailing from New Zealand, January 1, 1908, Shackleton established his permanent station at Cape Royds, Ross Island, at the base of Mt. Erebus. The expedition returned in 1909 with its members in health and its work done with wonderful success. In addition to the meteorological work at Cape Royds, the famous volcano Erebus was ascended and studied, the south magnetic pole located and visited, while the southern party attained a point within 93 geographical miles of the south pole.

FARTHEST SOUTH.—Very brief reference will be made to this extraordinary journey in which Shackleton and three companions in 127 days traveled 1,755 miles, an average of 13.8 miles daily, the party in its earlier travel being aided by Manchurian ponies who were killed and eaten.

For nearly 400 miles the route lay nearly due south, over the Great Barrier which is practically on the sea-level. Mountains then barred a south course in about 83° S., when they discovered Beardmore glacier valley which enabled them to proceed with slight deviations. This glacier proved to be a difficult, dangerous pathway, its crevasses nearly costing their lives while pressure ridges and moraines made progress slow up the steep ascent—6,000 feet in 100 miles.

The glacial valley was between sandstone and slate mountains, in which were found fossils and coal to about 86° S., where the mountains vanished and there was visible only an immense, unbounded, ice-covered plateau. The ice rose steadily and was still rising to the south when through lack of food the party turned back on January 9, 1909, from a point in 88° 23′ S., 162° E., at an elevation exceeding 11,000 feet. For weeks the party never had the temperature above zero Fahrenheit.

This southern journey was made under such conditions of intense cold, constant danger and continued semi-starvation, as makes its simple record a most thrilling story for adventurous or sympathetic natures. While it does not differ in its material aspects from many polar journeys it had a spiritual side that must appeal strongly to every true scientist.

Geological specimens were collected from time to time on the outward march, the farthest within about 300 miles of the pole, and all gathered up on their return. Chilled by low temperatures, suffering from bruises and strains through glacier travel, with depleted strength, prostrated at times by dysentery, and once traveling 31 hours without solid food, the party not only dragged these specimens some 500 miles homeward without abandoning them but even refrain from mentioning this load, drawn at the risk of their lives, save to say "at the ice-edge [near home] taking on only . . . specimens."

A similar heroic spirit of scientific devotion was displayed by David Mawson and Mackay in locating the magnetic pole. It was only by desperate, repeated and prolonged efforts that they reached the surface of the continental ice-cap of South Victoria Land, where they pursued to success their magnetic work. It was not alone that they experienced most trying physical sufferings, but that they also faced the extreme hazard of their lives, knowing that with the advancing season the sea would open during their prolonged absence and leave them without food.

Such heroic examples in the field match well the sacrificing spirit of scientific research so often displayed within the environment of modern civilization.

MOUNT EREBUS.—The ascent and survey of this lofty active volcano were productive of interesting data. Rising to the height of 13,350 feet, its four superimposed craters have for centuries overlooked the great oceanic ice cap, contrasting aspects of eternal fire and enduring ice.

When discovered by Ross in 1841 the crater was discharging molten lava which flowed down in streams.

Professor T. W. E. David gives an interesting account of the mountain. Of its three inactive craters the oldest rises to 6,500 feet with a diameter of six miles, while the second is two miles across at an elevation of 11,350 feet. The outline of the third, at 12,200 feet, was almost obliterated by the material of the modern active cone and crater which rose about 800 feet above the former.

The active crater of Erebus, three times as deep as that of Vesuvius, is about 900 feet deep, and one half a mile in diameter.

> Molten lava still wells up into the crater. . . . Fresh volcanic bombs on comparatively new snow are evidence that Erebus has recently been projecting lava to great heights.
>
> A most striking feature was the long row of steam jets about 300 feet below the inside rim of the crater.
>
> The ice fumaroles (some 50 were seen) are especially remarkable. These unique ice-mounds

have resulted from the condensation of vapor around the orifices of the fumaroles.

It will be obvious that Erebus is very interesting geologically on account of its unique fumaroles, its remarkable feldspar crystals and rare lavas, and as a gigantic tide gauge to record the flood level of the greatest recent glaciation of Antarctica.

Accounts of several eruptions are given in which the ejected steam rose from 6,000 to 10,000 or more feet above the crater.

BIOLOGY.—As might be expected, far the greater portion of biological data pertain to bird life, especially to the penguins, whose habits and methods are treated with interesting fulness.

Save rare specimens of the lowest forms of lichens, mosses and algæ, vegetation was entirely lacking. Doubtless the most important observations were those relating to microscopic fresh-water animals, of which Murray says:

On some of the moraines the growth of mosses and lichens was, comparatively speaking, luxuriant. A dried-up pool, close by the penguin rookery, . . . was covered by green filamentous algæ. Around smaller lakes was seen a dingy green or brown plant resembling some of the foliaceous lichens in form.

The plant-life consisted of various spheres and threads of blue-green algæ. The animals were more abundant . . . the rotifers and water-bears most important in point of numbers. [There were] thread-worms; . . . protozoa, each of a single cell . . . active infusoria . . . and the slow-moving rhizopods. . . . Skins of animals higher in the scale, . . . mites related to the cheese mite, small shrimps (crustacea) . . . were occasionally found.

A temperature of $-40°$ F. did not kill the rotifers. They were alternately frozen and thawed weekly for a long period and took no harm. They were dried and frozen, thawed and moistened and still they lived. They were dried, the bottle in which they were immersed in boiling water and still a great many survived.

Such is the vitality of these little animals (rotifers and water-bears) that they can endure being taken from ice at a minus temperature, thawed, dried and subjected to a temperature not far short of the boiling point, all within a few hours. . . . These are animals comparatively high in the scale. The rotifers are worms, and the water-bears are cousins to the insects and spiders.

Of the twelve kinds of creeping rotifers two were viviparous, one belonging to a genus (*Adineta*) of which no other known member is viviparous.

Dredging in depths less than 100 fathoms "the bottom appeared to be carpeted with a dense growth of living things."

Scant space is given to marine biology, perhaps as of little popular interest. There were obtained sponges, sea-weeds, anemones, tunicates, big-headed fishes (*Nototheia*), carnivorous whelks (*Neobuccinum*), tube-dwelling worms, crustacea, corals, sea-butterflies, diatirus, sea-spiders, etc.

Of the phosphorescence displayed by some of the worms from the bottom and by the copepods of the open sea, Murray says:

The phosphorescence is displayed by cold-blooded animals, living in a temperature always some degrees below the freezing-point of fresh water, and it is shown equally throughout the winter.

GEOLOGY.—Professor T. W. E. David and Mr. R. E. Priestley discuss the geological data in connection with those of preceding Antarctic expeditions. In the Victoria Land region previous researches, especially those by H. T. Ferrar, disclose:

An ancient complex of gneisses and gneissic granites, with mica-schists, calc-schists and quartzites, and that these rocks are capped for a great distance by a formation almost horizontally bedded, called the *Beacon sandstone.*

Amongst volcanic rocks are comprised horneblende-basalts, olivine basalts, dolomites, basalt tuffs, kenytes, phonolitic trachytes and phonolites. Amongst the foundation rocks of South Victoria Land Prior records crystalline limestones with chondrodites, gneiss, granites, diorites, camptonites, kewantites and banakite.

David says:

The oldest rocks seen by us . . . consist of banded gneiss, gneissic granite, grano-diorite and diorite rich in sphene. In some spots masses of very coarse white crystalline marble are interspersed in the gneiss. . . .

The next oldest sedimentary rocks appear to be the greenish grey slates brought by the Southern Party from the surface of Beardmore glacier . . .

in approximately 84° S., . . . fragments blown on to the ice from . . . mountains further west.

The most important geological inferences put forward are:

The Beacon sandstone formation, which extends for at least 1,100 miles from north to south in Antarctica, contains coniferous wood associated with coal seams. [In 85° S. 7 coal seams aggregating 25 feet in thickness were found in one sandstone cliff, associated with coniferous wood.] It is probably of Paleozoic age.

Limestones, pisolitic in places, in 85° 95′ S., and 7,000 ft. above sea-level, contain obscure casts of radiolaria, which appear to be of older Paleozoic age.

The succession of lavas at Erebus appears to have been first trachytes, then kenytes, then olivine basalts. Erebus is, however, still erupting kenyte.

Peat deposits, formed of fungus, are now forming on the bottoms of some glacial lakes near 78° S.

Raised beaches of recent origin extend at Ross Island to a height of 160 ft. above sea-level.

SOUTH MAGNETIC POLE.—Of great popular interest, as well as of especial scientific importance, was the definite location of the south magnetic pole, a most valuable work done by Professors E. David, D. Mawson and Mr. A. Mackay. It involved an outward journey of unusual difficulties, which occupied three months and eleven days. Two months of arduous labor, constant suffering and repeated failures were experienced before the party succeeded in attaining the surface of the continental ice-cap of South Victoria Land, whereon the pole is situated, 260 miles inland. They were quite at the limit of their provision supply, as well as of their physical strength, when they reached on the ice-cap the pole, on January 16, 1909, in 72° 25′ S., 155° 16′ E., at an elevation exceeding 7,000 feet. Their necessarily prolonged journey nearly involved the lives of the party as the open sea cut them off on their return, but they were picked up fortunately by the *Nimrod.*

Professor Douglas Mawson, who made the observations, says:

In the interval between 1841, when [the south magnetic pole was approximately located from his ship by Sir James Clark Ross] . . . and 1902, when the *Discovery* expedition again located the magnetic pole, it had moved about 200 geographical miles to the eastward.

Observations of magnetic declination and dip taken at intervals . . . indicate that the magnetic pole has [since 1902] moved in a northerly and westerly direction.

The determination of the *exact center* of the magnetic polar area could not be made on the spot, as it would involve a large number of readings taken at positions surrounding the pole. Such observations [were impossible] under conditions of such low temperatures [about zero] and prevalent high winds.

AURORA AUSTRALIS.—Auroras were frequently observed, but rarely in the direction of the magnetic pole. Mawson says:

When at their greatest brilliancy the displays were powerful enough to throw shadows [confirming similar observation by the Lady Franklin Bay expedition in Grunell Land], but were yet insufficiently strong to allow of their being photographed. We obtained impressions, of little value, on photographic plates after about ten minutes' exposure.

TIDAL OBSERVATIONS.—By ingenious devices the tide was automatically registered, on a barograph drum, for about three months. The usual tidal movements were marked by oscillations, chiefly during blizzards, considered to be in the nature of *seiche* waves.

The tide record was a simple undulating curve with one maximum per day, attaining the greatest amplitude at full and new moon, and diminishing almost to nothing at the quarters.

When the record was analyzed it was resolved into two undulations, the larger one having the period equal to the lunar day, the smaller one having a period of half a day.

The tidal range is not given in the narrative, but from the reproduced record, without scale, it would appear to range from about 8 inches in the neaps to about 35 inches in the springs.

METEOROLOGY.—Tabulated meteorological data are wanting as is frequently the case in popular accounts of polar expeditions. It is, however, evident that the bi-hourly meteorological observations of Shackleton's party, con-

joined with those of his predecessors in this region, will be a valuable contribution to Antarctic climatology and meteorology, when discussed and published in detail.

Barometrical observations are lacking, but the comments of Murray are especially interesting, and worthy of close scrutiny, that the usually close relations between the wind and barometric changes were absent, though there was an evident connection between the wind and changes of temperature. He adds that violent blizzards were frequently experienced while the barometric pressure was steady or changing slightly, while rapid barometric changes were often noted during fine and relatively calm weather.

Judging from the reproduced barometric chart for May and June, 1908, the normal variations are small, as they only ranged from a maximum of 29.44 on May 7 to a minimum of 28.30 on June 17.

Temperature Observations.—As they are always of unusual interest in polar work, it is unfortunate that the greater number of observations were of temperatures below zero Fahrenheit. As the expedition had no mercurial thermometers scaled below zero, such observations were necessarily made from spirit thermometers, which usually tend to unduly low records, owing in part to the instrumental inaccuracies and in part to frequent derangements and untrained manipulation of the thermometers.

As to the exceedingly low temperatures of the great south polar plateau, with its elevation of more than eleven thousand feet, it should be borne in mind that they were in large measure due, to the extent of about fifty degrees, to the normal cold of elevation; they are therefore not strictly comparable with the temperatures at Cape Royds.

The annual mean temperature of Cape Royds, approximating zero Fahrenheit, although unusually low, is yet four degrees higher than that experienced by the Lady Franklin Bay expedition at Fort Conger, 81° 44′ N., 1881–1884. The monthly means at Cape Royds are approximately as follows: January, 25° F.; February, 13°; March, 4°; April, —12°; May, —11°; June, —13°; July, —16°; August, —16°; September, —12°; October, —4°; November, 14°, and December, 26°. While the three coldest months (June to August) are comparatively warm with their aggregate mean of —15°, the three warmest months (November to January) are extremely cold with their mean of 22°. It is not surprising that only the very hardiest forms of vegetable life are able to survive such an unfavorable land environment.

With reference to violent temperature interruptions, there are reproduced combined temperature and wind records for May and June, 1908. These charts show regular and intimate relations between wind and temperature changes. In every case, seven in all, of high winds rapid and great increments of temperature systematically followed. This intimate relation, Professor David states, obtains only in the winter season, practically disappearing during the summer months.

It appears that the high winds, sixty to seventy miles an hour, always came as part of the southerly blizzards, concerning which it is said:

> The temperature invariably increased considerably from the beginning of a blizzard towards its end. This rise was very marked (from) perhaps — 30° F. . . . after 24 or 30 hours . . . to plus 15° F.

While Professor David suggests as possibly one of the important causes of this rise in temperature the usual Föhn compression, the reviewer considers it as practically the whole cause.

When abnormal barometric gradients near the south-polar plateau set up atmospheric movements with even a slight northern tendency, the intensely cold air of the polar plateau naturally follows the path of least resistance. This is through the valley of Beardmore glacier, with its downward gradient of 6,000 feet in sixty miles. The descent of such air-masses from an elevation of 11,000 feet to the sea-level must proceed with increasing velocity for the wind, while the rise in temperature must approximate sixty degrees from compression, independent of the latent heat set free by the accompanying snow-fall.

Winds, Surface and High-level.—*Surface*

winds at Cape Royds were either north from the sea or southerly from the plateau. On the southern journey south-southeast winds predominated, occasionally veering a few points. The direction was thus largely due to topographical conditions. At the farthest, 88° 23′ S., the many sastrugi trended from the south-southeast, and all blizzards were from that direction.

The record of the higher winds is most important. As Cape Royds is practically at the base of volcanic Mt. Erebus, the constant volcanic steam-cloud served as a gigantic wind-vane which was usually in full view. It developed that there were three normal wind-currents—the *surface* up to about 6,000 feet, the *middle-level* thence to about 15,000 feet, and the *high-level* above all. The direction of the *middle-level* was definitely shown by the many strongly marked sastrugi, from 11,000 to 12,000 feet, to blow from the west-southwest. Occasional eruptions sent steam-clouds upward from the crater of Erebus to a height of twenty thousand feet, and these cloud-streamers displayed clearly and persistently *high-level* current from the northwest. Interruptions and reversals of the various upper currents were noted in connection with violent blizzards. The detailed observations should throw much light on the atmospheric circulation of the southern hemisphere.

Precipitation.—This was entirely in the form of snow, which usually falls during blizzards. The annual amount at Cape Royds equalled about 9.5 inches of rain. The buried depot on the Great Barrier showed in six years and four months about 45 inches of melted water, or more than seven inches annually of rain.

ICE-CAPS AND GLACIERS.—Shackleton's journey furnished much information on the physical conditions attendant on the great Ice Age, of which the only surviving examples of note are Greenland and the continent of Antarctica —the latter of enormously greater extent and importance.

While existing data justify the belief that the ice-cap of Antarctica covers an area fifty per cent. greater than the continent of Europe, we now have positive evidence of an unbroken expanse of inland ice extending north and south more than 1,100 statute miles in a right line, from 72° 25′ S., the magnetic pole of Mawson, to 88° 23′ S., the farthest of Shackleton, and covering an arc east and west of fifty-five degrees of longitude south of the 78th parallel of latitude.

Erratic blocks and other proofs indicate that the thickness of the northern edge of the continental ice-cap near South Victoria Land exceeded by some two thousand feet that of the present wonderful inland ice.

Of the ice of the south-polar plateau at an elevation of 9,600 feet, Shackleton writes:

> I do not think that the land lies very far below the ice-sheet, for the crevasses on the ridges suggest that the sheet is moving over land at no great depths. The descent, towards the glacier proper, is by a series of terraces.

Everywhere were evident signs of waning glaciation. Erratic granitic blocks of enormous size were found on the flanks of Mt. Erebus, while in 85° S., on the summit of Mt. Hope, 3,350 feet above the sea and 2,000 feet above the surface of the adjacent glacier, was strewn with erratic blocks.

Murray believes that during the period of recent maximum glaciation the ice-cap had a thickness of four thousand feet in parts of McMurdo Sound, now ice-free.

It is thus evident that in the period of maximum glaciation there existed very extensive oceanic ice-caps, which projected seaward far beyond the continental shelf. Even in late years these ice-caps were sufficiently projected to furnish tabular icebergs or snowbergs of enormous thickness and vast extent, though they appear to have been more numerous from fifty to eighty years since than to-day. The present detachments are yet enormous, and Shackleton's southern party heard the noise and felt the ice-vibrations attendant on the breaking-away of the sea-front of the barrier while fifty miles distant.

Three examples of oceanic ice-caps, or barriers, yet remain: Drygalski Barrier, 200 feet elevation, fifty miles by twelve in surface, which projects 30 miles seaward with three fourths afloat; Nordenskiöld Barrier, of fifty feet elevation, twenty by five miles in surface,

entirely detached from the inland ice and afloat. Finally, the Great Barrier, of yet unknown extent, discovered by Sir J. C. Ross in 1841.

Shackleton's discoveries add very materially to the known area of the wonderful Great Barrier. The northern front of this oceanic ice-cap, which formerly extended at least one sixth around the globe on the 76th parallel, now covers forty-two degrees of longitude near the 78th parallel, a sea-frontage of about 470 statute miles. Its known projection seaward exceeds 400 statute miles, as its landward origin was determined by Shackleton to be south of 83° 30′ S., while its surface is in 77° 45′ S. He estimates its average elevation at 150 feet, and it seems most probable that the Barrier is afloat through the greater part, if not all, of its known extent. It is doubtless an under-estimate to place the superficial area of the Great Barrier at 200,000 square miles.

Formed as are all ice-caps of névé, the Great Barrier is peculiar in that it has not been subjected to great vertical pressures, and consequently has a low specific gravity, as is proved inferentially from a detached tabular snowberg which grounded in water about half its depth or thickness.

While the Great Barrier is fed only to a very slight degree by the inflowing glaciers, yet its movement seaward is doubtless due to some degree to the impulse given by enormous pressures from the great incoming glaciers of adjacent lands, especially from the mountains of South Victoria Land. For instance there must be a pressure of incalculable but vastly enormous power from Beardmore glacier, which has a surface area of over five thousand square miles, an average thickness of possibly a thousand feet, and necessarily a great velocity of movement due to its average fall of sixty feet to a mile throughout its length of one hundred miles. Some idea of this force may be gathered from the fact that it "raises pressure ridges on the Barrier for twenty miles out from its junction therewith."

The rate of superficial increase of the Barrier from local snowfall, and its rate of seaward movement are approximately known through a depot of provisions made on the ice in 1902 and uncovered six years and four months later. There had been an increase of 98 inches of snow, an average of 15 inches of unmelted snow annually, and an average annual movement seaward of "a little over 500 yards a year," about three tenths of a mile.

It would appear that the portion of the barrier farthest from the sea (over 400 miles) might be twelve hundred years in reaching the open ocean, and could then have acquired a thickness of 1,500 feet, provided it was wasted with normal rapidity. Ross in 1841 and Shackleton in 1908 observed portions of the sea-front where the cliffs rose 250 feet above the open ocean.

It is apparent that the sea-face of the barrier is steadily and rapidly disintegrating, as it has receded more than thirty miles since 1841.

The suggestion that "a great deal of (the inflowing glacier ice) may be thawed off from below by the sea-water" can not be accepted as undoubtedly the ocean has a uniform temperature of about 28°. Repeated observations for about three years by the Lady Franklin Bay expedition in the Arctic regions proved that the immersed portions of ice-floes of the northern seas, being fresh-water ice of land origin, are preserved indefinitely.

Glaciers.—Space fails in which to consider at length the many interesting observations on Antarctic glaciers visited and discovered. The two floating piedmont glaciers, Nordenskiöld and Drygalski barriers, have been elsewhere mentioned. The former is believed to be "moving actively from inland seawards," and there were 660 fathoms of water along its fifty-foot sea-face eighteen miles from shore.

The largest known ice-river of the world is the Beardmore Glacier, situated between 83° 33′ and 85° S., discovered and traversed by Shackleton and his Southern party. It is equally wonderful in its extent, its environment and its rapid movement.

One hundred miles in length and fifty in width, its surface area approximates 5,000 square miles. Through a glacial valley shut in between lofty sandstone mountains, the glacier falls 6,000 feet in its course of 100

miles, and is the only visible outflow from a vast unknown expanse of the south-polar ice-cap. Confined to a certain extent by lofty mountains and forced into a tortuous route, it is scarred by countless ridges and broken by thousands of crevasses. Receiving at its head enormous masses of névé it transforms them by the well-known processes of compression and expansion, of melting and regelation into glacial ice of the hardest, densest quality, and in most varied forms.

Of the surface conditions Shackleton records:

Sharp blue-edged ice, full of chasms and crevasses, rising to hills and descending to gullies. . . . One crevasse (where Marshall fell through and was saved by his harness) open from the top, with no bottom to be seen . . . a drop of at least 1,000 feet. . . . In another, the last pony dropped out of sight, the broken swingle-tree saving Wild. . . . We marched 9 miles over a surface where many times a slip meant death. . . . Followed the bed of an ancient moraine, full of holes through which boulders have melted down.

[Of the country] the wonderful scenery, the marvelous rocks. . . . A wonderful view of the mountains, with new peaks. . . . [In 84° 10′ S.]

The main rocks of the mountain under which we are camped . . . the erratics of marble conglomerate and breccia are beautiful, showing wonderful colors, . . . a wonderful sight as [the mountain] towers above us with the snow clinging to its sides. . . . [In 84° 54′ S.] Rock mainly sandstone with six seams of coal.

Fitting surroundings these for such an ice-river—issuing from the highest plateau of the world.

To crown the scientific observation is the very brief medical report which records that there was no case of scurvy or other sickness, apart from temporary sufferings of the half-starved southern party on its return.

PHYSIOGRAPHY.—From a broad standpoint the southward extension of South Victoria Land, the discovery of eight mountain ranges and scores of peaks, the reaching of the vast ice-clad plateau and the locating of the south geographic pole on tableland approximately 12,000 feet in elevation, may be considered as the most important of the scientific labors of the expedition.

The southern journey disclosed the continuity of Antarctica for about 1,250 miles due north and south, from Cape North to Shackleton's farthest. It thus establishes beyond peradventure the actual existence of a southern continent as announced by Wilkes in 1840, and as conjecturally charted by Sir John Murray in about 1875.

Moreover, the many ranges of lofty mountains, with the extent and great elevation of the wonderful south-polar tableland, clearly classify Antarctica as the most remarkable of continents not only in its conditions of glaciation but also in its surpassing elevation. Well-considered calculation places, with a possible error of ± 200 meters, the mean elevation of Antarctica at 2,000 meters, more than twice the average elevation of Asia.

Not only is it of scientific interest that the great, almost landless Arctic Ocean is opposite the enormous uplifted mountainous Antarctica, but the mass and location of this vast southern continent, one and a half times greater in surface than Europe, should serve to solve or elucidate vexed problems of latitude-variations and pole-shiftings. If not a practical factor for the far future these conditions may well have been so during past ages, when a milder climate, abundant animal life, luxuriant vegetation and forestal growths obtained in the vicinity of the present north and south geographical poles.

REGION OF WILKES LAND.—Of geographic importance is Shackleton's discovery on his return voyage of an extension of the north coast of South Victoria Land some 45 miles to the westward. This ice-bound mountainous coast connects in all probability with the land of Wilkes, whose priority of discovery has been lately put beyond question by Admiral Pillsbury, U.S.N.

GENERAL RESULTS.—Briefly summarized the most important scientific results of Shackleton's expedition are:

1. Culminating data establishing the existence of an Antarctic continent.

2. The definite location of the south magnetic pole.

3. The existence of a continental mass twice greater in elevation than any other continent.

4. Geological data showing the structure of Antarctica.

5. Evidences of a former mild climate and extensive vegetation in the vicinity of the pole.

6. Meteorological data elucidating the atmospheric circulation of the southern hemisphere.

7. The highest tableland of the world, with the location of the south geographic pole on an unbroken ice-cap.

It thus appears that Shackleton has solved the difficult problem of equally satisfying by his expedition the demands of science and the expectations of the public.

A. W. GREELY

U. S. ARMY

SPECIAL ARTICLES

PREDICTION OF RELATIONSHIPS AMONG SOME PARASITIC FUNGI

A FLOWERING plant which would produce two separate and dissimilar sorts of fruit would indeed be a curiosity, and yet there are some of the common parasitic fungi which exhibit two, three and even four kinds of fruiting bodies or spores. In addition to the variability displayed by many species of fungi in the production of different sorts of spores, a large number of the rust-fungi present a still greater complexity of existence by having the life-cycle divided into two distinct alternating phases, which inhabit wholly different and unlike host plants, such as a sedge and a composite, or a broad-leaved deciduous tree and an evergreen.

In these species which are known to change hosts and on that account are termed heterœcious, the one phase consists usually of æcia, accompanied by one other spore-structure, the pycnium, and the other phase of telia, either alone, or accompanied by uredinia.

The combination in one species of these pleomorphic and heterœcious characters may make the working out of the life-history a very difficult problem. The connection or relation between two alternating phases is best shown by means of cultures. A culture in which a spore from one phase on one host is sown upon another host, and subsequently gives rise to a spore-form of the alternating phase, is the only conclusive evidence that the two phases are related and merely represent different forms of the same parasite. Cultures, therefore, must play an important rôle in the study and investigation of the rust-fungi, especially of those forms which are not only pleomorphic but also heterœcious.

In order that the culture work may be carried on in an expeditious manner, entailing as small an amount of unprofitable labor as possible, it is essential that the experimenter should be guided by some ideas of probable relationships between alternating phases. It often happens that there is nothing in the form or habit of either fungus or host which will give the slightest hint regarding the alternate host. In such instances a notion of relations can be gained only by field observations. The finding of spore-structures of two alternating phases in close proximity in the field is usually the only obtainable factor indicative of a connection between them. This is the case with many of the species of the genera *Puccinia* and *Uromyces*, the common rusts of grasses and sedges. The association of telial and æcial stages is, to be sure, not proof of their affinity, but only a bit of prima facie evidence. The closeness of the association, the abundance of the infection, and the occurrence of stages of other species must all be taken into account. A great deal has already been written[1] emphasizing the value of these observations of association in the field and it seems unnecessary to make further explanation here, suffice it to say that this method of gaining clues to relationships is largely a deductive one. From the fact that related alternating phases are often found associated together, we infer that other associated phases may be related. Association, in

[1] See "Clues to Relationship among Heterœcious Rusts," *Bot. Gaz.*, 33: 62–66, 1902, and "A Search for Rusts in Colorado," *Plant World*, 11: 69–77, 1908.

other words, might be considered a general law among heterœcious forms.

In addition to this deductive method, which requires field observations upon which to base its inferences, there is another method by which predictions of relationship may sometimes be inductively made. In some instances there is something peculiar about either host or fungus, or both, which will permit the formation of an hypothesis. These peculiarities may be in form, habit, range or other characteristics, and are usually of such a nature that they may be studied out in the herbarium or laboratory. This second method deals very largely with the principles of analogy and homology.

It is the analogical method of inferring that what is true of one species is probably true of others similar to it which makes us conclude, for instance, that the species of *Coleosporium*, common rusts of the composites especially, are related to leaf-inhabiting forms of *Peridermium* on pine trees, that the species of *Cronartium* are connected to bark-inhabiting forms of *Peridermium* on pine trees, and that the *Gymnosporangia*, the cedar-rusts, have *Rœsteliæ* on members of the apple family as their æcial forms. This general theory for the assignment of certain form-species to their telial genus has already been illustrated in a paper of which the writer was junior author,[3] and subsequent culture work has demonstrated not only the accuracy of the predictions, but also the importance of such theorizing.

The writer wishes now to call attention to still better examples of the application of this analogical process. Perhaps the procedure may be made clearer by a fuller statement of the formula and the consideration of some concrete examples. The examples will be drawn from the group of cedar-apple fungi, *Gymnosporangia*, because of the writer's familiarity with this group.

Analogy has been explained in this way: Two things which are similar in one or more respects are of the same general type or character; therefore a certain proposition which is true of one is likely to be true of the other. In applying this to the fungi, as well as in other cases, it is especially important that the characters selected for comparison should be fundamental ones and not merely of a superficial nature. Some accumulated knowledge in a field, even if it should only be in the form of negative answers to previous conjectures, may not be without value in forming new hypotheses.

The following example may be cited in which cultures have already shown the correctness of an hypothesis formed by the method just explained.

Some time ago what appeared to be a true *Rœstelia* was found upon an herbaceous plant of the rose family. This was considered remarkable because it had always been supposed that all *Rœsteliæ* inhabited only woody plants of the apple family. Upon thorough examination, however, this was found to have all of the morphological characters of the rœstelial forms and it was, therefore, concluded that it was most likely associated with a cedar-rust, as other members of this form-genus are. There was in the range no unattached species of *Gymnosporangium* known which might have such a connection; this discovery called, therefore, for the detection of a new form. From the great resemblance of this rosaceous *Rœstelia* to the æcial form of *Gymnosporangium Nidus-avis*, a rather common and well-known cedar rust, it was predicted that the telial stage, when found, would resemble *G. Nidus-avis*. This new telial stage has been collected and cultures have been made proving the correctness of the assumption as to relationship. The prediction as to structure was also strikingly fulfilled, showing that it is not only possible to show the probable existence of new forms by this method but even to anticipate their characters. This species has been named *Gymnosporangium exterum* and a fuller account of its discovery together with original description and culture record may be found in *Mycologia*, 1: 226, 227, 253 and 254, 1909.

[3] See "North American Species of *Peridermium*," *Bull. Torrey Botan. Club*, 33: 403–438, 1906.

The writer ventures to offer the following conjectures of relationship with the hope that cultures may some day prove their correctness. They may turn out eventually to show only the errors which the method of analogical inference may lead to, but they serve well to illustrate its application to this subject and are offered with the hope that they may have some value.

Rœstelia hyalina on a species of hawthorn, *Cratœgus*, is a peculiar form which has been very little known up to the present. So far as the writer can make out there is no published record of any but the original collection from South Carolina made in 1860. The writer has recently rediscovered it on some herbarium specimens of the host plant at the New York Botanical Garden and the Arnold Arboretum so that its occurrence is after all not so rare; its distribution is now known from North Carolina to Florida. This adds new zest to the attempt to trace out its alternate phase. Morphologically *R. hyalina* has two very striking characters; first, the entirely smooth walls of the peridial cells, and second, the small wart-like protuberances on the leaves in which the peridia are borne. Only one other known species, *R. Botryapites* on *Amelanchier*, the service-berry, has these characters and it has seemed to the writer for some time that these two forms must be related to similar telial stages. *R. Botryapites* is known to be connected to *Gymnosporangium biseptatum* on the white cedar, *Chamœcyparis thyoides*. *G. Ellisii* is another white cedar rust, similar to *G. biseptatum* in the form of the distortion produced on the host and in the character of the spores, both having 2–4-celled teliospores. *G. Ellisii* has been supposed by some to be connected to *Rœstelia transformans* on *Aronia arbutifolia*, but a careful examination of the culture record shows that this conjecture has never been successfully demonstrated. On the other hand, there are so many negative results that it seems almost safe to conclude that it has been disproved. It seems very probable that since one of these two forms of *Rœstelia*, forms which are in a class by themselves on account of their smooth peridial cells and external anatomy, belongs to a white cedar rust of a certain type, that the other may belong to the only other white cedar rust of the same general type at present known. Recent collections of *G. Ellisii* by Stone in Alabama and Tracy in Florida make its known range from Massachusetts to Alabama so that it is quite feasible to suppose it connected with a form which is known in the heart of that range, North Carolina to Florida.

If an hypothesis provisionally formed either by association or analogy can be supplemented by inferences drawn from homology it is very materially strengthened. Homology might be defined so far as its application to botany is concerned as the morphological likeness existing between elements which may have become adapted to quite different functions. In applying this to the subject under discussion, for instance, if there is an essential structural resemblance between the æciospores and the urediniospores of a species they may be said to be homologous. Some notable examples in which homology in this sense has assisted in detecting genetic relationships have already been recorded by Dr. J. C. Arthur in his first report of "Cultures of Uredineæ"[3] and may be mentioned here.

Field observations had suggested that *Puccinia Vilfœ* on a grass, *Sporobolus longifolius*, was related to *Æcidium verbenicola* on *Verbena*. It was found that the closer the *Verbena* plants stood to tufts of the rusted grass the more thickly they were covered with æcia, and that the plants some distance away were entirely free. This is a good example of the working of the law of association. Before cultures were made, however, a resemblance in form was observed between the æciospores of *Æcidium verbenicola* and the urediniospores of *Puccinia Vilfœ*. The two sorts of spores were similar in shape and surface markings, and both had colorless walls much thickened at the apex. Later successful cultures proved that this homology was not a mere accident in this case and suggested that it might be the sign of relationship in other instances. During the same year a similar morphological correspondence was found between the æciospores of an *Æcidium* on *Fraxinus*, the ash tree, and the urediniospores of a *Puccinia* on *Spartina*, cord-grass, and with this as the only clue cultures were attempted. They were successful and thus

[3] "Cultures of Uredineæ in 1899," *Bot. Gaz.*, 29: 274–275, 1900.

showed the value of inferences drawn from homology.

The writer now desires to make one other prediction concerning a possible relationship, and the character of a form yet to be discovered, in which both analogy and homology have been employed.

In his paper on "Cultures of Uredinæ" in 1908 Dr. J. C. Arthur reports the establishment of a relationship between *Æcidium Blasdaleanum* and *Gymnosporangium Libocedri*. As explained there *A. Blasdaleanum* is morphologically unlike the other *Ræsteliæ*, having instead, characters like the ordinary æcial forms of *Puccinia* and *Uromyces*. However, it inhabits hosts belonging to the apple family, the hawthorn and service-berry, and these cultures show that it is undoubtedly genetically connected with a cedar-rust. There is, in the Pacific coast region, another æcial form of the same type, on members of the apple family, *Æcidium Sorbi* on the mountain ash and crab-apple. Although *Æcidium Sorbi* is of the same general type as *A. Blasdaleanum*, it has some very pronounced characters which show that it is specifically different. There is in the whole Pacific slope region at present no known *Gymnosporangium* except *G. Libocedri* and it is at once apparent that the telial stage of *A. Sorbi* is still to be discovered. There is, however, within this range a cedar-rust in the form of *Uredo Nootkatensis* on *Chamæcyparis Nootkatensis*, the yellow cedar, from Alaska. That *Uredo Nootkatensis* is the uredinial stage of a *Gymnosporangium*, which has in its life-cycle an æcial stage on hosts belonging to the apple family, has been previously suggested.[4] The basis for such an argument has been furnished by the elucidating researches of Dr. Arthur of which his new classification[5] of the Uredinales is the result. From this work it appears justifiable to assume that the production of all four spore-forms, pycnia, æcia, uredinia and telia, was doubtless the early condition in evolution, and that the suppression of one or more of these forms is a result of later influences. In most of the groups or tribes this four-spored condition not only still persists but usually the larger number of species belong in that class. Arguing from this point of view Dr. Arthur has predicted that sooner or later a *Gymnosporangium* ought to be discovered which would possess uredinia, *i. e.*, have all four spore-forms. Since the uredinial stage is unknown in any of the true *Gymnosporangium-Ræstelia* combinations it seems probable that if it exists at all it is likely to be in a species which has an æcial form like that of the species of *Puccinia* which ordinarily possess uredinia. With the above ideas as a basis the writer suggests the possibility of a relationship between the cedar-rust, *Uredo Nootkatensis* and *Æcidium Sorbi* on the mountain ash and crab-apple. Baranoff Island, Alaska, is the type locality of the *Uredo; Æcidium Sorbi* has also been collected on the same island, an item from geographical distribution which lends further support to the supposition. Arguing from a comparison with *G. Libocedri*, the only cedar-rust known to have the puccinia-type of æcia, the new telial stage should be foliicolous and have spores two or three times septate. If the above contention is true it may well be asked why *G. Libocedri* should not have a uredinial stage if there is anything in analogy. The answer is that it probably does but that it is unknown because no well-directed attempt has yet been made to collect it.

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[4] *Bull. Torrey Botan. Club*, 35: 501–502, 1908.

[5] "Eine auf die Structur und Entwicklungsgeschichte begrundete Klassifikation der Uredineen," *Résult. Sci. Congr. Bot. Vienne*, 331–348, 1906, and "Reasons for Desiring a better Classification of the Uredinales," *Jour. Myc.*, 12: 149–154, 1906.

THE MIOCENE HORIZONS AT PORTERS LANDING, GEORGIA[1]

The following section of the exposure at Porters Landing is adapted from the description of it given by Mr. Earle Sloan in his "Catalogue of the Mineral Localities of South Carolina," page 273.

[1] Published by permission of the Director of the United States Geological Survey.

	Feet
6. Pleistocene—white, red and yellow sands, with phosphatic pebbles and vertebrate fragments at the base	64
5. Miocene—compact, yellow, fossiliferous marl (Duplin horizon)	6
4. Miocene—grayish, fossiliferous marl (Marks Head marl)	29
3. Fine-grained, laminated shale with sandy partings, a line of rounded pebbles at the base	14
2. Oligocene—fossiliferous marl (Alum Bluff formation)	½
1. Laminated, drab shale with arenaceous partings	8
Total	111½

Recent collections made at Porters Landing have rendered possible definite correlation of the two Miocene horizons with those of the areas further north. From bed no. 5 of the section 34 identified species were obtained, 30 of which also occur in the Duplin marl of North Carolina. The four species which have not as yet been reported from there occur in other localities in horizons the stratigraphic equivalent of the Duplin, or in deposits of later age. Bed no. 5, therefore, can be definitely correlated with the Duplin marl of North Carolina and the fossiliferous Miocene marls of Darlington and Mayesville, South Carolina.

The Marks Head marl, which was first named by Sloan, and is represented by bed No. 4 of the section, contains specimens of the genus *Carolia* which suggests an Oligocene age, but every other identifiable species may be Miocene, and only three of them range downward into the Oligocene. Nine of the species are not known below the Miocene, and of these nine, six are confined to the Miocene. The horizon is, therefore, Miocene, while the presence of *Turritella æquistriata* Conrad, *Calliostoma aphelium* Dall, *Ostrea mauricensis* Gabb, and *Pecten marylandicus* Wagner, definitely point to a horizon low in the series, approximately equivalent to the Calvert formation of Maryland.

The recognition of the stratigraphic position of this horizon is of importance, as it is the only low Miocene horizon known south of Virginia. Further south in Florida, along the western extension, on the Ocklockonee and Apalachicola rivers, the Miocene rests upon the eroded surface of the upper Oligocene. The Miocene deposits of these localities represent a horizon high in the series. Therefore, the Marks Head Miocene is the equivalent in part to the erosion interval between the upper Oligocene and the Miocene of western Florida.

Bed no. 2 of the section at Porters Landing contains fossils indicative of an upper Oligocene age. Bed no. 3 is very likely of Miocene age, and the line of rounded pebbles at the base suggests that the Miocene may rest upon the eroded surface of the upper Oligocene. It seems probable that along the Savannah River an erosion interval occurred between Oligocene and Miocene depositions, but the interval was of shorter duration than in western Florida.

T. WAYLAND VAUGHAN

THE AMERICAN SOCIETY OF ZOOLOGISTS CENTRAL BRANCH

THE annual meeting of the American Society of Zoologists, Central Branch, was held in the splendid new Natural Science Hall of the University of Iowa, Iowa City, on April 7, 8 and 9, 1910, Dean Edward A. Birge, of the University of Wisconsin, presiding. Thirty zoologists of the central states registered.

Resolutions relating to the International Commission on Nomenclature similar to those adopted by the Eastern Branch at the December meeting were passed, and the following zoologists were appointed as a committee to cooperate with the International Commission: C. C. Nutting, C. H. Eigenmann, C. A. Kofoid, H. B. Ward, S. W. Williston.

Officers for the ensuing year were chosen as follows:

President—C. E. McClung, University of Kansas.

Vice-president—H. F. Nachtrieb, University of Minnesota.

Secretary-Treasurer—H. V. Neal, Knox College.

Executive Committee—R. H. Walcott, University of Nebraska, W. C. Curtis, University of Missouri, Oscar Riddle, University of Chicago.

The following, having received the votes of the

executive committees of both branches were elected to membership in the Central Branch: J. T. Patterson, University of Texas; Robert T. Young, University of North Dakota; John W. Scott, Kansas City High School; F. D. Barker, University of Nebraska; Albert Kuntz, University of Iowa; Chancey Juday, Wisconsin Geological and Natural History Survey; H. W. Norris, Grinnell College.

The following are titles and abstracts of papers presented at the meeting:

Some Personal Peculiarities of Lakes (president's address): EDW. A. BIRGE, University of Wisconsin.

The paper dealt with certain unusual, but regularly recurrent phenomena in the temperature, dissolved gases and carbonates of several inland lakes, and with the biological meaning of such phenomena. On the annual rhythm of physicochemical changes in a lake, produced by the march of the seasons, there is superimposed another annual series of similar changes, due to biological causes. These last are in large measure regular and determined by general laws; but in part, and especially in their details, are peculiar and "personal" to the several lakes. They result from the establishment of habitual interactions between the members of the plankton and between plankton and environment.

Inland lakes contain a complex and practically closed assemblage of plants and animals, which have lived together for centuries, in an environment substantially unaltered from year to year and whose exchanges with the outer world are minimal. Thus the lake with its plankton has come to be a sort of organism of a higher order, showing definite and regular internal changes and reactions not unlike those of an organism—changes not so definitely expressed or so definitely dependent on biological causes in any other assemblages of organisms. In certain lakes we find habitual reactions, unexpected *a priori*, and in this respect not unlike reactions of higher organisms.

Inland lakes, therefore, offer to the student definite and varied ecological problems of much interest and complexity. These concern the relation to each other of members of the plankton, the effects of plankton on environment and the resulting influence on plankton of environmental changes. Such problems are by no means wholly general, to be solved by the study of a single lake, but they offer many features which are special and personal to individual lakes.

Feeding Reactions of the Rose Coral (*Isophyllia*): F. W. CARPENTER, University of Illinois.

When the rose coral polyp is stimulated by meat juice the oral disk is drawn downward by the contraction of the retractor muscles of the mesenteries, and the margin of the oral surface is folded inward over the disk by the action of a well-developed sphincter muscle. Meanwhile, the stomodæum is everted, and the mesenterial filaments are extruded both through the mouth and through temporary apertures in the oral disk. Carmine particles dropped on the oral surface of an expanded polyp are transferred by ciliary action to the periphery. When the carmine grams have previously been soaked in meat juice the cilia usually continue to beat in an outward direction; occasionally, however, they reverse their effective strokes. The tentacles react quickly to contact stimulation, and affix the touching object to their knob-like distal ends, which are heavily loaded with nematocysts.

In normal feeding, which occurs after dark, small organisms in the plankton are affixed by the tentacles, the oral disk sinks, and the marginal zone of the polyp folds inward until it completely roofs over the tentacles and the depressed oral disk. Into the superficial chamber thus formed the stomodæum and mesenterial filaments project, and here the mesenterial filaments, which are the digestive organs of the polyp, probably digest and ingest or absorb the captured plankton, little of which finds its way into the reduced gastro-cœlomic cavity. Extra-cœlenteric digestion appears, therefore, to take place in rose coral polyps.

The Factors which Control the Leaping of the Pacific Salmon: HENRY B. WARD, University of Illinois.

Open water jumping was observed best among salmon swimming about in a pound net or trap. The same fish does not execute a series of leaps, but only a single jump. Features in the position and movements of body and fins show that it is neither an effort to escape capture nor preparation for the ascent of the stream later. It must be regarded as a type of play which, however, finds expression only as the reproductive period approaches. It occurs first at the time when the reproductive organs are entering upon their final growth period.

Jumping at falls manifests in several particulars of position and movements of body and fins a definite relation to the purpose of surmounting the obstacle. In a large per cent. of cases the

effort is unsuccessful and displays apparent lack of accuracy in direction as well as distance of height. Since the fish jump for the most part in parallel lines perpendicular to the face of the fall, one would expect to find some definite disturbing influence to explain the apparently erratic leaps. Such an influence is present in the confused water currents at the base of the fall. The sudden and irregular changes in the whirlpools and swirls where the fish lie waiting for an opportunity to jump no doubt act to modify the direction of the leap and cause the fish at times to execute apparently aimless jumps. The jumping was most regular at the point where the current was most constant.

Reproduction and Parasitism in the Unionidæ: George Lefevre and W. C. Curtis, University of Missouri.

Further Experiments on the Egg-laying Habits of Amphitrite: John W. Scott, Kansas City High School.

Experiments on the Control of Asymmetry in the Development of the Serpulid, Hydroides dianthus: Charles Zeleny, University of Illinois.

A Statistical Study of the Sex-cells in the Early Stages of Amia and Lepidosteus: B. M. Allen, University of Wisconsin.

Function of the Spermatozoon in Fertilization, from Observations on Nereis: Frank R. Lillie, University of Chicago.

The author succeeded in destroying the sperm nucleus within the egg at stages as much as twenty minutes apart shortly after the time of its entrance, and found that while such eggs, which had formed the fertilization membrane and started in development, continued until the formation of the second polar body, they did not form a complete cleavage spindle and the egg remained unsegmented. The female pronucleus of such eggs formed the chromosomes but no definite segmentation spindle, and asters were practically absent. This was true even when one of the maturation divisions had formed the polar nucleus inside the egg, as sometimes happened, so that the quantity of maternal chromatin equaled that of the fertilized egg. It follows, therefore, that fertilization is incomplete for some time after the entrance of the spermatozoon into the egg, in the case of *Nereis*, and that its completion is not merely a quantitative chromatin factor.

The result was obtained by centrifuging eggs at regular intervals from the moment of fertilization on. There was found a certain period soon after the entrance of the spermatozoon when the mechanical shock destroyed the sperm nucleus in large proportions of the eggs. This was determined by a cytological study of these eggs and their controls in the maturation and fertilization stages. The percentage of eggs thus studied and found to be devoid of a sperm nucleus corresponded quite accurately with the percentage of eggs observed to remain unsegmented in the living eggs of the same series. At the critical stage selected for comparison, the determination of the presence or absence of the sperm nucleus is a simple matter. Stimulation of the unfertilized egg with potassium chloride, or a mechanical shock, will suffice to cause the formation of the fertilization membrane and of the polar bodies, thus producing exactly the same effect as the first penetration of the spermatozoon, and no more, for these eggs also did not segment.

Fertilization can not, therefore, be regarded as exclusively a surface phenomenon. It must be interpreted as, in some sense, a continuous process, lasting for some time after the penetration of the spermatozoon, possibly until the union of the germ nuclei. As one of the first effects of penetration is demonstrably increase of permeability, it may be that the later function of the spermatozoon is essentially similar throughout the entire thickness of the protoplasm, by overcoming, so to speak, a certain resistance to permeability in successive strata and creating a consequent free oxidation in the interior of the egg. The mass of the egg cell is obviously in excess of the functional optimum for oxidation, and increased permeability of only the surface would hardly be expected to bring about free oxidation throughout the whole.

It is practically certain that the destruction of the sperm nucleus by centrifuging did not mean its expulsion from the egg in these experiments, but merely suppression of its power of growth, or dissipation of its substance. Its material remains within the egg; but, existing only as so much chemical matter, it does not exercise a fertilizing effect. Its fertilizing power is in some way bound up with its organization and growth.

The Chromosomes of Anasa tristis: C. E. McClung, University of Kansas.

Generic Definitions: C. C. Nutting, University of Iowa.

Some Parasites of the Sleeper Shark in Icy Straits, Alaska: Henry B. Ward, University of Illinois.

Somniosus microcephalus Le Seur is common in Icy Straits. Its range extends through the Arctic waters to the North Atlantic. Specimens examined in Europe are regularly infested with a gill parasite, *Squalonchocotyle borealis*. This ectoparasitic trematode undergoes, no doubt, direct development. It occurs abundantly on Alaskan specimens of the same host. Four other internal parasites are recorded from this host in the Atlantic. These undergo probably indirect development and hence need one or more intermediate hosts. The sleeper shark in Alaska harbors species from the same genera as those in the Atlantic, but they are related rather than identical parasites. As in the case of land animals, so in this marine host, the species of parasites which infest it vary in different portions of its range.

Some New Cases of Trihedral Tænia: F. D. BARKER, University of Nebraska.

The examination of 37 dogs at the University of Nebraska from November, 1903, to April, 1910, yielded 601 *Tænia serrata* and 450 *Tænia serialis* in addition to a large number of other species of *Tæniæ*. Among the *T. serrata* were four trihedral or prismatic tæniæ and among the *T. serialis* were three trihedral forms. This increases the number of reported trihedral tæniæ to thirty cases and adds two new species to the list. The specimens resemble two tapeworms, the one fused along its side to the face of the other. Each scolex has six suckers arranged in three groups of two each. The rostella are armed with two rows of hooks, but the number of hooks in each row is less than the normal. One or two genital pores occur in each mature proglottid, one pore to a crest. The trihedral condition affects the musculature, the nerve trunks, the excretory canals and the reproductive organs. The onchospheres have six to twelve hooks.

These trihedral forms probably arise from a double embryo produced by the partial separation of the first two or early blastomeres and not by a fusion of two normal embryos.

A Comparative Study of the Development of the Sympathetic Nervous System in Birds and Mammals: ALBERT KUNTZ, University of Iowa.

Medullary cells migrate from the neural tube into the ventral nerve-roots. With similar cells which wander out from the spinal ganglia, these cells migrate peripherally along the spinal nerves. Some of these cells deviate from the course of the spinal nerves and give rise to the sympathetic trunks and the prevertebral plexuses. The vagal sympathetic plexuses, viz., the cardiac plexus and the sympathetic plexuses in the walls of the visceral organs, arise from cells which migrate from the hind-brain and the vagus ganglia along the vagi.

The great majority of the cells which migrate peripherally from the neural tube and the cerebrospinal ganglia are the "indifferent" cells of Schaper. Among these are found a few "neuroblasts" of Schaper. Therefore, the sympathetic neurones are homologous with the efferent and the afferent components of the other functional divisions of the peripheral nervous system. Mitotic figures occur occasionally along the course of migration and in the sympathetic anlagen. We are not to suppose, therefore, that all the cells taking part in the development of the sympathetic system actually migrate as such from their sources in the cerebrospinal system. Doubtless, a goodly number arises by the mitotic division of "indifferent" cells along the course of migration.

Certain morphogenetic differences occur in the development of the sympathetic system in birds and mammals which, doubtless, indicate that the sympathetic system has departed more widely from the original type in birds than in mammals.

The sympathetic system may be looked upon as an accession to the nervous system which has arisen comparatively late in the evolution of vertebrates in response to the conditions of the vegetative life.

The Histology of the Nasal Mucous Membrane in Mammals: WM. A. LOCY, Northwestern University.

An illustrated account of the structure and of the histogenesis of the nervous elements in the sensory epithelium of the nose of the pig and rabbit with some remarks on the question of the direction of growth of nerve fiber.

The Lymphatic System of Turtles: FRANK A. STROMSTEN, University of Iowa.

The points considered in this paper were the anatomy of the lymphatic system of *Chrysemys marginata* and the development of the lymph hearts of the loggerhead turtle. A preliminary paper with figures giving the results of this investigation is to be published at once elsewhere.

The Bermuda Biological Station for Research: F. W. CARPENTER, University of Illinois.

The Work of the Illinois Biological Station: STEPHEN A. FORBES, director, Illinois State Laboratory of Natural History.

This station differs from most American fresh-water stations, in the fact that its equipment is all afloat, and readily movable from place to place; that it is devoted to investigation only, and not to teaching; that it is in operation throughout the year instead of being limited to the vacation season; that it is devoted to a study of the biology of a river system instead of a lake; and that it is supported directly by appropriations from the treasury of the state.

Opened in April, 1894, it remained at Havana, Ill., for five years; was then transferred forty-five miles down the Illinois to Meredosia, where it continued for two years and two months; thence up the Illinois a hundred and sixty-five miles to Ottawa, where it remained for a year and a half; and then to Henry, forty miles below. Here it was laid up to permit the preparation and publication of papers and reports setting forth the main results of its work; but it became active again, at Havana, July 1, 1909.

During the first two years its field work was comprehensive of all aquatic forms and situations, the next three years were devoted mainly to plankton work in the Havana district, and the following four to work on the fishes of the Illinois system. Of the 6,000 collections made during this period, about 500 were fishes, 2,000 were plankton collections, and 3,500 contained a general variety of aquatic and subaquatic forms. Six hundred and forty of the plankton collections were made at Havana by strictly quantitative methods, and are available for a comparative study of the product of various waters at all times of several successive years. Weekly samples of the waters were examined by chemical methods for three and a half years. Besides these local studies, steamboat trips were made for considerable distances, with continuous plankton collections throughout each trip. Longitudinal biological sections of the stream were thus made, aggregating four hundred and fifty miles on the Illinois River and three hundred and sixteen miles on the Mississippi between St. Louis and Quincy.

The main object of the station operations for the coming two or three years will be to complete a comparison of present conditions with those of the former time; to study the river as a unit with special reference to its economic and hygienic protection and improvement; to work out the details of its biological regimen, by a separate study of special problems; and to carry on comparative studies between the Illinois, the Mississippi and the Missouri, all readily accessible from the station field. Its most recent work has been directed to a comparison of present conditions with those before the opening of the Chicago drainage canal and to a collection of materials for further studies of the food of fishes, and for physical and chemical studies of the bottom in selected situations as related to differences in biological production. From weekly collections continuing for four months it appears that the plankton of the main stream is now approximately double the amount per cubic meter that it was before the opening of the drainage canal, notwithstanding the fact that the water averages about three feet higher than it did before that event.

The Indiana University Biological Station: FERNANDUS PAYNE, Indiana University.

Hydroids from the Illinois River: FRANK SMITH, University of Illinois.

A Report on the Fresh-water Protozoa of Tahiti: C. H. EDMONDSON, Washburn University.

Some New Species of Cretaceous Fish from Kansas: C. E. MCCLUNG, University of Kansas, (Read by title.)

Investigations on some Lakes in Guatemala and Salvador: CHANCEY JUDAY, University of Wisconsin.

Restoration of Cacops aspidephirus, a remarkable new rhachitomous Amphibian from the Texas Permian: S. W. WILLISTON, University of Chicago. (Read by title.)

The Fairport Biological Station:[1] ROBERT E. COKER, director.

A biological station has been established by the United States Bureau of Fisheries at Fairport, Iowa. The immediate work of the station will be in the cultivation of fresh-water mussels, experiments and investigations relating to the propagation and natural history of the forms important in relation to the pearl button industry and the pearl fishery. The ultimate scope of the station is broad: it is expected as soon as possible to have all facilities of a station thoroughly equipped for the investigation of problems of fresh-water biology. During the present year operations will be conducted with a preliminary equipment, consisting of gasoline pumps, a series of small ponds with reservoir, and a temporary laboratory.

Are Muscle and Nerve primarily connected? H. V. NEAL, Knox College.

[1] By permission of the United States Commissioner of Fisheries.

The "Plasmodesmata" of Held and Paton, connecting myotome and neural tube, are not primary intercellular bridges, but are secondary connections of medullary origin. The "neurofibrillæ" are intracellular differentiations of the neuraxon processes of medullary cells. The methods used in the study of the histogenesis of the neurofibrillæ do not seem suited to the study of the development of the "plasmodesmata."

The Teaching of Zoology and some Suggestions for its Improvement: W. J. Baumgartner, University of Kansas.

The paper showed that many more students take botany than zoology in the secondary schools. Some reasons were cited for this. Universities can help the teaching of zoology by furnishing some material. The teaching of zoology can be improved by assigning the student a special animal to report on to the rest of the class.

Cestode Cytology: R. T. Young, University of North Dakota.

Both in larva and adult new nuclei in many cases arise *de novo* in masses of cytogenic protoplasm. The evidence of this is the appearance of small, densely staining chromatin bodies in these masses. These later surround themselves with membranes (or the membrane may arise first and the chromatin body later) and are then constricted off from the cytogenic mass, together with a small amount of cytoplasm to form new "cells." Some nuclei are typical, consisting of membranes surrounding distinct chromatin nucleoli; while in others the entire "cell" body is filled with diffuse chromatin, as is shown by micro-chemical tests. A count of some 34,000 nuclei showed only fifty cases of possible mitosis. Amitotic division of preexistent nuclei also occurs. It is probable that mitosis is degenerating in the cestodes, corresponding to their general degenerate condition.

Fifty-one Generations in the Dark: F. Payne, Indiana University. (Read by title.)

DEMONSTRATIONS

Sections showing the Early Sex-cells of Amia and Lepidosteus: B. M. Allen.

Some Parasites of the Sleeper Shark: H. B. Ward.

Hydroids from the Illinois River: Frank Smith.

Sections showing the "Plasmodesmata" connecting Myotome and Neural Tube in Squalus: H. V. Neal.

H. V. Neal,
Secretary

Knox College

SOCIETIES AND ACADEMIES

THE ANTHROPOLOGICAL SOCIETY OF WASHINGTON

The 446th regular meeting of the Anthropological Society, held April 12, 1910, was devoted to the retirement address of the president, Dr. J. Walter Fewkes, on "Cave Dwellers of the Old and New World." The full text of this address will be published later.

The unity of the human mind, said the speaker, has come to be one of the most fruitful working hypotheses in the science of culture history. Identities in human culture, under similar climatic and other environmental influences are among the strongest evidences that can be adduced in support of this theory. As human habitations, the most characteristic of racial artefacts, reflect better than all others the effect of environment, the object of the address was to indicate the bearing of a comparative study of cave dwellings from different geographical localities on the theory of mental unity.

A people of nomadic life whose habitations from their mode of life are perishable has little stimulus to construct lasting monuments. Sedentary people, on the other hand, construct habitations of material that will endure; caves when available naturally first afforded shelter for races seeking permanent dwellings.

It is difficult to find a primitive race where human culture has reached any considerable architectural development that has not, at an early cultural period, lived in caves or holes in the ground. Life in caves leads to buildings made of stone or other lasting materials. Permanence of building perpetuates racial traditions, serving as constant incentives to the construction of architectural monuments.

A study of the distribution of prehistoric cave habitations reveals a marked uniformity of cave dwellings in regions of the earth geographically far apart. Prehistoric cave dwellings of similar form may be traced from China across Asia and on both shores of the Mediterranean, in Mexico, Peru and the southwestern part of the United States. This distribution corresponds in a measure with that of great prehistoric monuments and follows closely that of the arid regions.

Caves as habitations are divided into two types, natural and artificial. The address treated more particularly of the latter, but views of both from the old and new world were shown.

The European natural cave as a shelter is prehistoric, having been abandoned in very early times. The natural caves of Cuba, Hayti and

Porto Rico were, however, inhabited by primitive men of low culture and characteristic speech when America was discovered.

Artificial caves in the Verde Valley, Arizona, were shown to resemble those in Asia Minor, the Crimea, Caucasus Mountains and Canary Islands. Exact counterparts of the "tent rocks" or "cone dwellings" of the Otowi Canyon, in New Mexico, occur in Cappadocia near Cæsarea Mazaca. Views were shown illustrating the resemblances of certain cliff houses in Arizona, and monastic establishments in Thessaly. The speaker called attention to an inhabited subterranean village Matmata, in northern Africa, and underground habitations, now deserted, in volcanic cones near Flagstaff, Arizona. The resemblance in architecture of a Berber village in the Sahara to a Hopi pueblo, was incidentally considered.

Views were shown of oriental rock temples, the most striking of which were those of the rock city, Petra, in Syria, which was characterized as the most exceptional cliff ruin in the world.

The 447th regular meeting of the Anthropological Society, held April 26, 1910, was also its 31st annual meeting.

The meeting opened with reading of the minutes of last year's annual meeting. The secretary then read a report of the activities of the society during the last session which, briefly stated, was as follows: The society held fourteen meetings with an average attendance of 64 members and guests. At these meetings twenty papers were presented by sixteen contributors.

The president, Dr. J. Walter Fewkes, commemorated in a few appropriate words the members of the society who during last session departed this life, viz., Professor Enrico Giglioli, of the Museum of Florence, Italy, who has been an honorary member, and Professor Simon Newcomb and Mr. W. C. Whittemore, active members.

The society then proceeded to the election of officers, which resulted as follows:

President—J. Walter Fewkes.

Vice-president—George R. Stetson.

Secretary—I. M. Casanowicz.

Treasurer—George C. Maynard.

Additional members of the Board of Managers (besides the former presidents of the society, who are *ex officio* permanent members of the board)—William H. Babcock, J. N. B. Hewitt, David Hutcheson, Edwin L. Morgan, John R. Swanton.

I. M. Casanowicz,
Secretary

THE MICHIGAN ACADEMY OF SCIENCE
SECTION OF ZOOLOGY

The regular meetings of the section were held March 31 and April 1, 1910, at the University of Michigan. The following papers were read:

"Notes on Michigan Reptiles and Amphibia, II.," A. G. Ruthven.

"Some New Light on the Development of Reptilia," E. C. Case.

"Variation in *Lymnæa reflexa* Say, from Huron County," H. Burrington Baker.

"The Crustacea of Michigan," A. S. Pearse.

"Preliminary Report on the Anatomy of *Physa gyrina* Say," H. Burrington Baker.

"Notes on the Distribution of the Unionidæ of North America," Bryant Walker.

"Regeneration in the Nerves of *Cambarus*," H. M. MacCurdy.

"A Contribution to the Theory of Binuclearity" (lantern slides), R. W. Hegner.

"The Origin and Meaning of the Second Polar Body," Chas. R. Barr.

"On Two Abnormalities in the Crayfish," Lucia Harmon.

"The Rotary Power of Extracts of the Bodies of Snails," Elliot R. Downing.

"The Formation of Habit at High Speed," O. C. Glaser.

"Notes on some of the Rarer Species of Michigan Birds," Walter B. Barrows.

"Methods of Photographing Birds" (lantern slides), R. W. Hegner.

"A Simple Cooling Device for Use with the Microtome," O. C. Glaser.

"A Word on Double Embryos," O. C. Glaser.

"The Theory of Mimicry" (lantern slides), Jacob Reighard.

"The Pearl Organs of American Minnows in their Relation to the Factors of Descent" (lantern slides), Jacob Reighard.

"Some Methods of Studying Vision in Fishes, with Demonstration of Apparatus," Crystal Thompson and Mary Axt.

"A Remedy for the Black Fly Pest in the Southern Peninsula of Michigan," Cora D. Reeves.

"Experiments on the Rôle Played by Odors in Determining the Behavior of Bees," Max Peet.

"Mimicry in *Tabanus atratus*," S. D. Niagers.

"The Mendelian Law Demonstrated by the Domestic Fowls," S. D. Magers.

R. W. Hegner,
Secretary

Ann Arbor, Mich.

SCIENCE

Friday, June 3, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

SCIENCE AND INDUSTRY[1]

The present age surpasses all previous epochs of history by the intense activity of the human race, the daring of its efforts, the magnitude of its accomplishments.

We know of periods in history where great wars, great political developments, migration, religious fervor, newly discovered lands, or other causes, brought forth considerable changes in some nations, but never was the movement so wide-spread in geographical location, never were impulses operating so rapidly, nor on so extensive a scale, as to-day.

We have not reached the end of this movement; quite on the contrary, it seems to gain in intensity as the years roll by.

While some few nations have taken the lead in certain lines of human endeavor, we know, on the other hand, that the same influences are at work even in the most remote corners of the world; countries which for ages have been dreaming dreams of rest, countries of which the political, intellectual, social or industrial conditions have remained practically unchanged for hundreds, nay thousands of years, begin to awaken; willingly or unwillingly, they too seem to undergo, albeit in a smaller degree, this all-pervading tendency of enterprise, this aggressive effort to better utilize their opportunities for material, social and intellectual betterment.

In other words, modern human dynamics have reached an intensity never witnessed before.

It looks to me as if all great feats re-

[1] Address of the president of the American Electrochemical Society, Pittsburgh, May, 1910.

corded in the history of our race sink to nothingness if compared to what human activity is accomplishing every day since ignorant, arrogant, emotional, spasmodic efforts are slowly but surely giving place to methodical and persistent work based on exact scientific knowledge.

Whether the human race has been made happier by all this, I shall not here try to decide. Happiness is a very subjective condition of mind, very difficult, if not impossible to measure or to compare: the happiness of the child or the savage and the happiness of the intellectually developed adult are two entirely different propositions. I believe, however, that even case-hardened pessimists ought to admit that our *opportunities for happiness* have considerably increased, even if so many people, not knowing better, continue to trample upon these very opportunities, blinded as they are by false ideals, or by misdirected aspirations.

True, the pessimist may point to the slums of large cities, to poverty, to vice, to unsatisfactory labor conditions, to high cost of living. But, what is all that compared with conditions in bygone ages? Where are the famines, the plagues, which not so long ago periodically devastated Europe, and which are still the scourge of some backward countries like India, China and Russia?

Political corruption, dishonesty and greed are still too much in evidence, and there is much room for higher ethics; on the other hand, anybody who wants to give himself the trouble to investigate real history will have to admit that the morals and conduct of life of many of the most exalted personages of the past, would fall far below the test of the plain average decent citizen of our republic to-day.

Most certainly, there is still abundant necessity for improvement; and our race will improve as long as we put more pride in raising better children than in finding an excuse for our littleness or a consolation for our failures, by bragging about the supposed importance of our ancestors.

Nowhere have the changes of this century been so accentuated as in our industrial enterprises. We know, furthermore, that just such industries, where the developments have been most staggering, are exactly those which have utilized scientific knowledge to the largest extent. Wherever the engineer has been able to put into practise the secrets which the scientist has wrung from nature's laws, there also do we see results so far in advance, as compared with what existed formerly, that only a man with a dead soul fails to be stirred up to admiration and enthusiasm.

The modern engineer, in intellectual partnership with the scientist, is asserting the possibilities of our race to a degree never dreamt of before: instead of cowing in wonder or fear like a savage before the forces of nature, instead of finding in these forces an object of superstition or terror, instead of perceiving in them merely an inspiration for literary or artistic effort, he learns the language of nature, listens to her laws, and then strengthened by her revelations, he fulfills the mission of the elect and sets himself to the task of applying his knowledge for the benefit of the whole race.

Let me assert it emphatically; the two most powerful men of our generation are the scientist and the engineer.

Society at large is far from realizing this fact, simply for the reason that the scientist and the engineer manifest their power not as despots, not as cruel tyrants. Their might is not put in evidence by the amount of chattel-slaves they hold in bondage, nor by the barbaric splendor of their lives; it is not marked by the devastation

wrought by armies; their work does not consist in conquering and subjugating weaker nations; we do not see them, glorified in painting and sculpture; we do not hear their exploits extolled in song and rhyme; no artists have had to record their triumphant homecoming, greeted as saviors and heroes while marching over the mutilated corpses of their fallen enemies; they do not use their power to sow sorrow, death and misery, or to steal and plunder or fill the museums of a city like Paris with treasures of art taken by force from weaker nations. No, the masses are unaware of the immense power of the scientist and the engineer because both of them modestly play the rôle of "the servant in the house"; their unassuming life is devoted not to slaughter, destruction or coercion, but to the service of mankind. They do not build useless pyramids cemented with the sweat and blood of overabundant slaves, monuments to vain glorious despots, witnesses to the small value which was put in ancient times on human life and on human labor.

But the modern engineer, applying the principles of science, raises buildings far superior in size and conception than any architecture of bygone ages can boast of; edifices incomparably more comfortable, more hygienic, more appropriate than anything built before. He raises those gigantic structures in as many days as it took years to build a temple.

In fact, after a few years, he is ready to pull the same buildings down, to erect better and bigger ones in order to suit advanced conditions, and nobody cares about the name of the architect or the engineer, nor does the builder care himself.

And why should anybody care? The dynamics of the age are producing changes at such a rapid rate, that nowadays any building, of whatever size it be, is begun with the feeling that before long it will have to come down to give place to new conditions. Erecting a twenty-story building in a city like New York is about like putting up a temporary tent, which may suit us for a while, but has to be taken down whenever conditions, in the onward march of civilization, demand it. Palaces and other buildings which would have made the pride of older nations are torn down now after a career of less than twenty years, to make room for the development of our cities, to allow larger and better adapted edifices to take their place, which probably in a relatively short time will follow their predecessors and be torn down in their turn, when our children begin to realize that they want streets four or five times wider than our now overcrowded thoroughfares.

The modern engineer and the scientist realize that much more enduring monuments than stone, brick or bronze will mark the work of this period: they know that the diffusion and application of exact knowledge is shaping the destiny of future generations and will afford more lasting evidence of their efforts than temples or statues; they believe that their work will not count merely for material betterment, but that improved material opportunities created by them will bring forth better people, higher ideals, a better society.

To put it tersely, I dare say that the last hundred years under the influence of the modern engineer and the scientist have done more for the betterment of the race than all the art, all the civilizing efforts, all the so-called classical literature, of past ages, for which some respectable people want us to have such an exaggerated reverence.

Consistent in their mission of true powerful men and of servants of our race, the

engineer and the scientist perform their work steadily but quietly; they are not appreciated by the unthinking multitude because of the fact that their modesty is usually as great as their achievements.

True, I know some of them who do not exactly "hide their light under a bushel"; but show me the most vain engineer or the most conceited scientist and he will appear like the very picture of meekness and modesty if you will put him alongside some artists, some writers of fiction, some opera singers, or opera composers.

Let me insist on the fact that every one of our betterments in material conditions, every increase in our opportunities in life has been the entering wedge of vastly improved social, political and ethical changes.

The steamships of to-day, to which the armadas of yore and the fleets of antiquity look like mere children's toys, bring distant nations, distant men, nearer together; so do the railroad, the press, the telegraph, the telephone.

Not only have time and distance been shortened by the industrial applications of science, but life has been lengthened in years, and still much more in accomplishments and in opportunities.

Improved means of communication do not only facilitate the exchange of products between far-away nations, and allow them to compete in quality and price in the most remote corners of the world's market, but they enable more lasting exchanges than merely those of material commodities; we intermingle, develop and distribute thoughts and knowledge which slowly but surely modify and perfect the political and ethical conditions of nations as well as of individuals.

Not so long ago, opportunities for travel, for education, wealth or comfort of existence, were given only to a very few; now in our modern community all these advantages have come within the reach of the multitude, and all this, thanks to our industrial developments.

Much has been said and written about the civilizing influence of the discovery of the printing press. Has it ever occurred to you that the printing press could accomplish very little if we had not invented the means for manufacturing cheap and good paper? In the same way, every facility which science and engineering has endowed the world with finds itself reflected in the ever-increasing development of printed publications. For one book that was written a few centuries ago, thousands, and better prepared ones, are published nowadays. Ancient authors had few competitors and few readers, and the latter could afford to remember the names of their authors, and greatly exaggerate their merits, and overawe following generations with the extent of their importance and hypnotize some of us into the belief that there are no good authors but dead authors, or ancient authors, an opinion unfortunately shared by some respectable pedagogues.

To-day, when illiteracy is no longer the rule but the exception, new ideas, new conceptions are carried to all points of the globe: measured, discussed, hacked to pieces, or developed, all this with a rapidity never attained heretofore; and I believe that one of the most important causes of our rapid mental and industrial progress is due to the very swiftness with which information and knowledge penetrate the masses.

The man who nowadays would try to stem the tide of ideas, or intellectual advance, would only succeed in making himself ridiculous.

In the middle ages, some devout people, not knowing better, could try to burn scientists and their books, and opposed for

a while the march of progress, because there were so very few scientists and so very few books to burn. But nowadays it would require more than all the combined blast furnaces of Pittsburgh to keep up this process of oxidation.

It helps a country like Russia very little to have some highly developed men, some great scientists, great philosophers, as long as the multitude of the rural population remain in ignorance and lowness; as long as so many people are prevented by unsatisfactory material conditions to profit by the influence of their better fellow men.

In a self-respecting community the benefits of modern conditions and opportunities for advancement are open for everybody and privileges of birth and class are now considered an anachronism, if not a crime, against the human race. Yet few men stop to compare the conditions of modern life with those of the good olden times. An average man who thinks himself underpaid and imagines he is living at a very modest pace, does not realize that when he is traveling in a modern railroad train he enjoys comforts and advantages never dreamt of by the richest or most powerful men, princes or kings, of scarcely a century ago; he forgets that his life is surer, that his health is better taken care of, than that of any potentate of former times; that the nation respects more permanently his rights as a citizen, than was the case of prime ministers of one or two hundred years ago; that his sons and daughters have better and surer opportunities of education and intellectual advancement, than the children of kings of past centuries; that there is no beautiful thought in this world, no knowledge, which is not accessible to him and everybody who can read.

Man only considers a thing a luxury as long as his fellow men can not get it, never mind whether it be a bit of glass or a diamond, a bicycle or an automobile; commodities of modern life cease to be considered as luxuries as soon as they become easily accessible to everybody.

Neither should we be too much disappointed in meeting so many people who seem to be oblivious to our improved conditions, as compared with those of former times. Society has been pushed ahead, against the will of the masses, by a few active, daring, restless men who forced the others to follow; just like a herd of unthinking sheep is unwillingly driven forward by the shepherd and his dogs. Many people among whom we live have truly been prodded into progress; they may properly be called remnants of bygone times, symptoms of mental atavism of the race; they do not properly fit in our age; they have passively drifted along on the advancing stream of centuries to be carried beyond where they properly belong, and now they constitute the ballast which impedes the dynamics of our modern generation.

It has been asserted so often by respectable people that science and industry cater only to our material welfare, and have little in common with culture, refinement or moral development; therefore I feel compelled to put special emphasis on this side of the question and to insist on the enormity of this error; on the contrary, the development of our industries, of our material prosperity, as well as the study and application of science, are the surest and most immediate forerunners of higher civic ideals, of an improved society, of a better race.

A clean, well nourished and well housed individual who can enjoy the comforts and advantages of modern surroundings, and leads an active, intelligent, productive, self-supporting and self-respecting life,

is certainly more of a man and a credit to his race than were some ancient saints who lived from alms and who spent their life in prayer and inaction, or who, for further edification of their followers, vowed never to change their clothes, nor wash nor shave nor comb themselves; he is more of a blessing to his fellow men than the useless drone who lives on the work of others and gives nothing in return but arrogant presumption based on fortune, rank or title inherited from his father.

If this be then the age of rational industrialism, of applied science, how then is it that in some industries quality is going down, while prices are soaring upwards?

Here again it is a noteworthy fact that just such commodities as are produced by so-called scientific industries are sold cheaper and are of better quality than ever before, and this cheapening of price or bettering in quality is almost proportionate to the amount of scientific knowledge involved in their production. Let us take, for instance, the chemical and the electrical industries, both based almost exclusively on well-developed scientific data. In both these groups of industries the chemist or the physicist has had full sway and the engineer has embodied their work in a practical form. Free and rational competition based on intellectual superiority has been their paramount factor of development. Competition based on artificial privileges like labor unions, tariff legislation, have played only a secondary rôle. While flour, meat, clothing and houses were considerably less expensive a hundred years ago than they are now, we find that acids, alkalies, salts, solvents, dyes, and, in general, almost all chemicals, are incomparably cheaper and of better quality than they were in the good olden times.

In some cases, the changes are remarkable. For instance, a ton of sulphuric acid sells now at the same price as two pounds of the same article were sold about a hundred and fifty years ago.

A similar cheapening can be found in many other chemicals, although their demand has immensely increased. Without going to extreme cases, we can state that there has been a steady improvement in most chemical manufacturing processes and that the public at large has had the benefit thereof. The same can be said of the electrical industry.

Compare this with industries which are still under the sway of the rule-of-thumb, which means the rule of the ignorant, or where competition is based on political protection; you will find that just such rule-of-thumb commodities where science plays no rôle, are those for which the public has to pay the highest price in return for the poorest article. Married men may follow this assertion from butcher's bills to ladies' hats, from house rents to servant girls.

For the poor chemist, it is almost an irony of fate that his science, by developing the "cyanide process," made gold cheaper and thereby reduced considerably the purchasing equivalent of his meager salary. In order to get square he will have to put himself now to the task of helping the engineer in the cheaper production of foodstuffs, or clothing, or take a hand in such tax reforms which may bring about a reduction of rent or may lessen other economic anomalies.

Notwithstanding all our progress, it is evident that we live in a transitory stage; next to enterprises and industries embodying the highest intellectual conceptions our century can offer, we find even in the most advanced countries examples of conditions

of affairs which seem truly an anachronism.

This must have impressed many of you who have happened to visit factories or mills where ignorance and greed seemed the two dominant factors, where the class of men and women employed, not to speak of child labor, seemed to have undergone the full curse of their sordid surroundings. Such places are to be found often where the mental condition of the directors does not enable them to go beyond the conception of size and where the whole tendency has been towards more, more, more, instead of towards better, better, better.

How different is this from some of our better engineering and chemical enterprises where everything bears the imprint of a steady effort towards progress and where employer and employed alike seem to undergo the uplifting force of intellectual aims. Such a happy condition of affairs is most likely to be encountered where the head is himself the scientific pioneer who has built up the enterprise.

Matters are not always so satisfactory where large organizations have got into the hand of a board of directors, who know little else of the technical side of the business than that it pays dividends, and for whom the main interesting factor is the value of the shares they own.

Whenever undertakings are ruled by such a class of men, we must not be astonished if their corporation counsel is more in evidence than their chemists or their engineers. What do they care if certain improvements in their processes might net them five per cent. more or mean better goods, if, on the other hand, they know that by a clever trick of law they can extract from the consuming public many times more; no wonder then if they have less time and less mental fitness for a principle of science or engineering involved in a new process, than for a conference with "eminent law counsel." If they can not alter nature's atomic weights, they may find a way of improving their invoice weights for the custom house to the detriment of Uncle Sam. I might use for our industries the forceful quotation of Shakespeare in Hamlet about the state of Denmark, as long as corporation lawyers of reputation are paid incomparably better and their services are sought for so much more eagerly than the very best chemists or the ablest engineers.

This brings to my mind the case of a company which held a charter to supply a certain city with illuminating gas, and which after enjoying a fortune-making monopoly for many years, found one day that special legislation had reduced the selling price of their product. Certain again of being able to upset this law, the company entered in long litigation, but finally, after repeated efforts, had to realize that even its best lawyers could not change matters. From that moment on, they began to inquire actively about better manufacturing processes. A friend of mine, who was requested to give his suggestion as to how they could improve their methods, replied as follows: "Up till now your company has been making *law*—now make *gas* and everything will come out all right."

Then again we find that, resourceful as the modern engineer or chemist is, his power is often simply a tool in the hands of ignorant but cunning men. In fact, our modern laws and society insure better reward for cunningness or slyness than for true intellectuality.

The very abundance of our natural resources may be partly to blame for this condition of affairs; in other countries, like Germany, with comparatively small natural means, competition shapes itself more

towards technical perfection. If we want to learn how to reduce what I would call our "nation waste," our German friends can give us valuable lessons. It is significant too that in large German engineering or chemical enterprises the board of directors is made up mostly of scientifically trained men, engineers, chemists and physicists. The entrance of the physicist in our industries has not yet become very evident, although in Germany it seems to be the rule, especially in electrical and other enterprises, to give to the physicist as much importance, and even more, than to the chemist; both of these scientific specialists leave the purely engineering problems to the qualified engineer.

The story was told to me how the head of one of the largest engineering firms in Germany won his spurs. Prices of copper were rising beyond precedent, and his merchant business associates insisted therefore that he should buy an amount of copper sufficiently large to supply them for their electric installations for several years to come. In the meantime, prices were going up faster and faster; but this did not seem to disturb the scientific director, who was eagerly following the results of some special research work, giving reliable data about transformers and high voltage transmissions. As he understood the law of Ohm, he knew that pretty soon, even if copper was three times higher in price, he could use so much thinner wire and save money in the end. What he foresaw happened; the price of copper dropped suddenly, and Ohm's law triumphed over copper speculators.

All this does not take away the faet that although some industries suffer from brutal ignorance, others have sometimes been handicapped by a too one-sided scientific organization; I know of some instances, especially in Germany, where very respectable enterprises have not utilized their available opportunities to the proper extent, because their scientific managers lacked good business sense. I have seen some industrial enterprises much held back by too much red tape and a choking amount of paper-wisdom. The most learned man without common sense or practical abilities can accomplish little except disappointments. Here is where the keen business man, with a practical turn of mind, with directness of purpose and good judgment, will every time show his advantages.

An overspecialized man, whether he be a biologist, a physicist, a chemist or an engineer, may lack the broadness of conception and action which characterizes true great men of many-sided development.

Then again, quite frequently the real field of usefulness of scientifically trained men is much misunderstood. For instance, it is a common mistake, made even by some engineers and physicians as well as by business men, to imagine that the main work of the chemist is confined to performing chemical analysis. This conception is about as absurd as to think that the main usefulness of an electrical engineer consists in making electrical tests, or that the essential work of the merchant is bookkeeping.

Many a good chemist has been thus prevented from showing his best abilities by the sheer ignorance of those who employed him.

In the development of some of our industries, nothing has played such an important rôle as scientific research work. To those who do not realize this, let me tell that not so long ago I had an opportunity in Philadelphia, to see that old electric machine of Benjamin Franklin, a small revolving glass globe mounted on a

wooden frame; this was about as far as electricity went a century ago. Shortly afterwards, I was confronted by those gigantic electric installations at Niagara Falls. To those who belittle the value of scientific research, I recommend a comparison between this and Franklin's machine, a mere scientific toy, a clumsy affair, that would at its best performance, and if the weather was not too damp, give off some small sparks; a contrivance so useless in its time and so devoid of apparent practical applications, that if some one had told to a "shrewd business man" of last century, what this field kept in store for us, he would merely have shrugged his shoulders in derision. But now behold the hundreds of thousands of electrical horsepower developed in those monstrous generators of Niagara Falls, sensitive as a slender nerve, and yet running with the precision of a watch; distributing power and light to distant cities like Toronto and Syracuse; running heavy railroad trains as surely as the tiny drill of the dentist; converting ores into metals; transforming hundreds of tons of brine daily into caustic soda and bleach; changing mixtures of sand and coal into carborundum; ennobling plain coal into graphite, or producing from coal and limestone new sources for illumination under the form of calcium carbide; or again fixing the nitrogen of the air on calcium carbide to change it into cyanamide, a most valuable synthetic fertilizer; and at every succeeding year, new chemical achievements of this kind are still being brought forward by a set of tireless workers.

Let me ask a fair question of those who underestimate the value of research: Has that stupendous gap between Franklin's toy and the power companies of Niagara Falls been bridged by anything but by scientific research of the highest order?

Some of the better educated people in this country begin to understand more and more the necessity of scientific research. Not so long ago, research work was only carried out in the laboratories of universities or in those of a few highly developed chemical or electrical companies; nowadays we find many intelligently conducted enterprises devoting a considerable annual outlay for systematic research work, where the resources of the chemist, the physicist and the biologist are used to good purpose.

Unfortunately, the scope and method of scientific research is difficult to understand for the uninitiated. Some people have only the haziest conceptions on this subject. Some manufacturers, totally unaware of the requirements involved in this work, in a half-skeptical way, grudgingly conclude to organize a research department, sometimes as a last resort to help them through some difficulties; others do it "to be in style" and simply to imitate their more successful competitors. Frequently they engage a young man with little experience, who, outside of what he studied in the technical school or at the university, has everything to learn, and who, besides that, is usually entrusted at the very start with the most difficult problems. His salary is none too high, and his action is very much restricted; sometimes he is forbidden to study the current practical methods, or so-called "manufacturing secrets," and is thus prevented from getting acquainted with the very problems he is supposed to solve. I have seen other cases where the time of the research chemist was filled with odd jobs of every kind. After a while, when practical results are not forthcoming fast enough, the bookkeeper confronts him with the list of expenses which have been incurred by his work; naturally some comments are ready at hand how the same money spent on a

good salesman would have shown immediate results, and so forth. Things go along that way for a while until the research department is abolished with the recurring remark: "Research does not pay, we've tried it."

In other cases, where some results are obtained, the matter is taken out of the hands of the chemist before he has had time to fairly try and develop it on a large scale. The subject is now entrusted to the superintendent or the foreman, who seldom is a friend of the scientifically trained man, and nearly always resents anything which might diminish the prestige of "established practical experience." Like in all new processes, defects are soon shown, and in the natural order of things, repeated failures and renewed trials on a practical scale are required before there is any possibility of regular utilization. The research chemist is allowed very little intervention at this stage of the work, and often, remarks are heard how imperfect the whole thing was "before so-and-so, the practical man, had his say." Finally initial expenses are charged against the research department, and profits credited to the "practical man."

A research department is a very difficult thing to organize and to run. It is not enough to provide a building and the necessary appliances; it is not enough to provide typewriters, card-indexing systems, and office force, and all the red tape connected with it; it is not sufficient to engage one or more well-behaved university- or college-graduates with the necessary helpers, and to let them work under an orderly businesslike manager. You might as well try to produce masterly paintings by installing an office management and a well organized paint and brush department, and a library containing all that has been written on the art of painting next to a splendidly equipped studio, and then leave out the real artist who will do the painting. Nay, the most important, the almost exclusive factor in a successful research laboratory is the research chemist himself. If he is not a man who has a soul alive with his subject, if he is not enthusiastically imbued with his opportunities, if he is not qualified for his task not only by scientific training but specially by a natural gift of discrimination between what is most important in a problem and what is secondary to it, you might as well fill a hall with the marble statues of Greek poets and imagine that they will write poetry for you.

Then if you find the man who has all the true qualifications, you may still paralyze his action by too much red tape, too much interference in his work. A good research chemist will do more and better work with pots and pans from the "ten-cent store" in a shed or in a barn, where he is his own master, than in a splendidly equipped laboratory where he gets irritated and interfered with by others who do not understand him.

I sometimes doubted whether it was really worth while for a young man to take up research work single handed, when so many people with abundant facilities were at work. What show, for instance, does an organic chemist have in studying a problem for which in Germany some large chemical companies employ hundreds of research chemists. To this I can answer that some of the most striking examples of successful research were the result of privately conducted work with modest means; in fact, I know of several instances where a research chemist who had created himself a reputation by work carried out privately under adverse circumstances, showed disappointing results as soon as he became part of a vast organization.

Even if you have the best qualified research chemists, do not expect immediate results. Do not forget that problems, appearingly most simple, require considerable time before they are thoroughly studied. Even in successful cases, it may easily require many, many years before a subject is so thoroughly elucidated that it can be taken up in practise.

Research is what gives a young man of strong individuality a chance to compete with those big industrial consolidations, the trusts, who, like elephants, look more imposing by their size than by their agility or perfection, and who, as that pachyderm, have many vulnerable spots, and are just as much handicapped by their lack of flexibility and by their ponderosity. Some steel manufacturers may be unable to think about anything but tonnage, and yet the work of some chemists has already indicated that the quality of steel of the future, or of its alloys, may be improved to such a degree that probably the average steel of to-day will look to our children as brittle and imperfect as pig iron appears to us. Neither should we lose sight of the fact that even to the most exclusive mechanical enterprises there is a chemical side, although the importance of the latter may not be apparent to the man who is not a chemist.

Let me give also a warning to such manufacturers who try to secure only by uncompromising secrecy, the money-making end of their industries.

As far as my experience goes, exaggerated secrecy is very often an indication of lack of knowledge, of industrial feebleness and incompetency; a miser is most of the time a man of small means.

If the chemists had been holding their results from each other, we should still be in the dark ages of the alchemist. No secrecy, however jealously carried out, can outweigh enlightened research work, protected by wise patent legislation. If our patent laws do not protect enough, then our prime duty becomes to change them until they answer their purpose as defined by the constitution of the United States. The care with which patent laws are administered is a direct measure of the industrial importance of a country. Piracy can not flourish, neither on the seas nor in intellectual property, if ethics of justice and equity can be made to prevail.

Every recorded success of the scientist or the engineer is an additional evidence that ignorant greed and brutal rapacity can not forever have full sway in this world, and that the rule of the sly and the shy leads to the abortion of progress. Furthermore, the results of their work, which bars out "chance," "luck" or "happenings," is their most eloquent language to convince their fellow men that if law-makers may still think that laws are made or unmade by them in Albany or Washington or Harrisburg, there is at least one law which can not be amended; at least one law which even the cleverest lawyers can not make to be interpreted in two different ways; a law which rules all men, large or small, poor or rich, to whatever nation they may belong; a law which rules the dead, and the unborn as well as the living; a law which requires no supreme court to test its validity; a law that can not be trifled with, which nobody and nothing can escape: the great unchangeable Law of Nature which rules the universe, mocks at men-made statutes and ordinances, and upsets and destroys everything which comes in conflict with her; the rigidly enforced law which tries to teach us our mistakes by suffering, by misery, by industrial or political crisis, by unhappiness, by war, so as to awaken us from our ignorant sleep, to show us our

misguided aims, and to command us to prepare a sounder, a happier condition for our children and future generations, while building up, during the trend of centuries, a slowly rising foundation for a higher humanity, a more god-like race.

LEO HENDRIK BAEKELAND

THE GENERAL EDUCATION BOARD

AT a meeting of the trustees of the General Education Board, held on May 24 in New York City, $682,450 in appropriations was voted. Of this sum $538,000 was appropriated conditionally for the endowment funds of eight colleges, $113,000 for the furtherance of demonstration work in agriculture throughout the southern states, and $31,450 for the salaries and expenses of special professors of secondary education in the several state universities of the south.

The appropriations voted in support of college endowments raised to $5,177,500 the sum already spent in this direction. The seventy colleges that have received these endowments during the last four years of the board's activities have each raised sums in endowment which taken with the board's gifts aggregate $23,670,500.

Conditional appropriations for endowment were made to these colleges in the following sums:

Cornell College, Mount Vernon, Ia., $50,000 in addition to a like amount subscribed at the last previous meeting of the board.

De Pauw University, Greencastle, Ind., $100,000.

Marietta College, Marietta, O., $60,000.

Allegheny College, Meadville, Pa., $100,000.

Central University, Danville, Ky., $75,000.

Drake University, Des Moines, Ia., $100,000.

Middlebury College, Middlebury, Vt., $50,000.

Transylvania University, Lexington, Ky., $50,000.

These eight colleges were selected from a list of twenty-nine who petitioned the board for assistance.

The sum of $113,000 appropriated for demonstration work in agriculture in the south was made in the furtherance of the efforts which Dr. Seaman A. Knapp, of the Department of Agriculture, is making in elevating agricultural conditions through the southern states by teaching intensive farming and the scientific methods of crop raising. In giving financial aid to this movement the General Education Board is cooperating with the department at Washington. Last year the board's contribution in this direction was $102,000, which was divided among the various states as follows: Florida, $5,000; Georgia, $32,000; South Carolina, $22,000; North Carolina, $24,000; Virginia, $22,000. In addition $8,000 was spent in the administration of this enterprise.

The money voted by the board for the salaries and traveling expenses of professors of secondary education in the south is to be spent, as previous appropriations have been, in fostering the growth of high schools. The board now has one such professor attached to the state universities of Virginia, North Carolina, South Carolina, Georgia, Florida, Alabama, Mississippi, Tennessee, Louisiana, Arkansas, West Virginia and Kentucky, provision for the last of which was made at the meeting. The sole duty of these professors is to urge throughout their several fields the establishment of high schools.

The trustees of the board who attended the meeting were Frederick T. Gates, Robert C. Ogden, Walter H. Page, J. D. Rockefeller, Jr., Albert Shaw, Wallace Butterick and Starr J. Murphy, of New York; Edwin A. Alderman, president of the University of Virginia; Hollis B. Frissell, president of Hampton Institute; Henry Pratt Judson, president of the University of Chicago, and Wickliffe Rose, general agent of the Peabody Education Fund.

SCIENTIFIC NOTES AND NEWS

WITH a view of collecting material for the life of Alexander Agassiz, any one having any of his letters will confer a favor by sending them to his son, G. R. Agassiz, Museum of Comparative Zoology, Cambridge, Mass., U. S. A. The letters of any one who so wishes will be copied and the originals returned to the owner as soon as possible. If any persons are unwilling to part with the

original letters, will they kindly have copies made at the expense of G. R. Agassiz, and send them to him at their convenience?

SIR ARCHIBALD GEIKIE has been elected a foreign member of the Danish Academy of Sciences at Copenhagen.

OXFORD UNIVERSITY has conferred the degree of doctor of science on Mr. P. H. Cowell, F.R.S., and on Mr. A. C. Crommelin, both of the Royal Observatory, Greenwich. They have also been awarded jointly the Jannsen medal of the Société Astronomique de France.

PROFESSOR W. T. PORTER, of Harvard University, has been elected a corresponding member of the Royal Society of Physicians in Vienna.

THE University of Edinburgh has conferred its doctorate of laws on Commander Robert E. Peary.

DR. OTTO KLOTZ and Mr. J. S. Plaskett have been elected fellows of the Royal Society of Canada.

DR. ALFRED M. TOZZER, instructor in anthropology at Harvard University, and Mr. R. E. Merwin have returned from an expedition to British Guatemala and Honduras. They bring back a collection of antiquities from the four ruined cities which they discovered during the winter's work, and also a collection of entomological specimens for the Museum of Comparative Zoology.

DR. PHILIP P. CALVERT, assistant professor of zoology in the University of Pennsylvania, and Mrs. Calvert arrived in Philadelphia on May 17, from Costa Rica, after a year's residence in that country. They were in Cartago, their headquarters, at the time of the earthquake of May 4, which totally destroyed that town, but escaped unhurt. A brick partition wall fell into the room in which they were sitting, burying and destroying the living insect larvæ which were in rearing, some of the experiments having run for eleven months. On the following day they were able to recover from the ruins nearly all their other collections, notes, photographs, instruments, etc., and later to bring them home in safety. Many data on the seasonal distribution, larval forms and habits of Costa Rican Odonata (the principal objects of their investigations) have been secured.

DR. J. W. SPENCER sailed on the *Hellig Olaf* to spend the summer in Norway, to continue physiographic researches, commenced during earlier visits to that country. He will also attend the International Congress of Geologists in Stockholm.

DR. M. P. RAVENEL, professor of bacteriology, will represent the University of Wisconsin at the centennial celebration of the University of Berlin from October 10 to 13. Dr. Ravenel is also American delegate to the International Conference on Tuberculosis at Berlin in October, and the International Congress on Alimentary Hygiene and the Rational Feeding of Man, in Belgium.

PROFESSOR G. F. SWAIN, of Harvard University, attended the dedication of the Carnegie Engineering Building at Union University, Schenectady, N. Y., and delivered an address on "Limitations of Efficiency in Engineering Education."

ON May 16, Dr. E. L. Hewett lectured before the University of Colorado Scientific Society at Boulder, on his recent work on the ancient monuments at Copan in Honduras and Quirigua in Guatemala. He has been able to determine the order of development of the art, his results according perfectly with the dates worked out independently from the glyphs by his colleague Mr. Morley.

THE Croonian lecture of the Royal Society was delivered on May 26, by Dr. G. Klebs, professor of botany at the University of Halle, his subject being "Alterations of the Development and Forms of Plants as a Result of Environment."

DR. GEORGE FREDERIC BARKER, emeritus professor of physics in the University of Pennsylvania, died in Philadelphia on May 24, at the age of seventy-five years.

PROFESSOR WILLIAM P. BLAKE, emeritus professor of metallurgy, geology and mining and director of the School of Mines of the University of Arizona and territorial geologist, has died at the age of eighty-four years.

Professor Franklin C. Robinson, of Bowdoin College and the Medical School of Maine, died on May 25. He had been professor of chemistry in these institutions since his graduation in 1873. He was a member of the American Chemical Society, the Society of Chemical Industry, a fellow of the American Association for the Advancement of Science, member of the Maine State Board of Health, chairman of the Maine State Survey Commission, and ex-president of the American Public Health Association.

Robert H. Gordon, long interested in the geology of western Maryland and the donor of extensive collections of the finely preserved Lower Devonic fossils of this region to the U. S. National Museum and to Yale University, died on May 10, at the age of fifty-eight years.

Mr. W. R. Head, for many years a collector and student of Paleozoic sponges, died at his residence in Chicago on May 10, at the age of eighty-one years.

Dr. Robert Koch, professor of hygiene in the University of Berlin, died at Baden-Baden on May 27.

The well-known city engineer and paleontologist of Reval, Russia, August von Mickwitz, died on April 20 last at the age of sixty-one years. His best known work in paleontology treats of the Upper Cambric Obolidæ and Lingulidæ of western Russia.

By arrangement between the Bermuda Natural History Society and Harvard University the Bermuda Biological Station for Research will be open this summer for about six weeks beginning the middle of June, under conditions substantially like those of previous years. For particulars application should be made to Professor E. L. Mark, 109 Irving St., Cambridge, Mass.

In 1906, on recommendation of the then Italian minister of public instruction Boselli, there was created by royal decree the Comitato Nazionale per la Storia del Risorgimento. In 1909 this committee, consisting of nineteen members, was organized, with Senator Finali, president of the Court of Cassation, as its head. Among its members are Ernesto Nathan, syndic of Rome; Professors d'Ancona, Bosselli, Martini, Abba, Pitrè and Casini; Marquis Emilio Visconti-Venosta, and Car. H. Nelson Gay, formerly of Boston, but for many years a resident of Rome, and the leading authority on the bibliography of the Risorgimento. The objects of the committee are (1) to establish in Rome, in the monument to Victor Emanuel, a museum, archives and a national library of the Risorgimento; (2) to promote Risorgimento museum and archives in the chief towns and cities of Italy; (3) to prepare and issue a bibliography; (4) to publish documents, and (5) to direct special works for illustrating the most important material. The committee already possesses many invaluable collections —the Crispi Papers, the Jessie White Mario Papers, Mazzini manuscripts, the Pepe correspondence, etc.; and when the new quarters are ready, there may be transferred to them the vast collections of the National Library at Rome. At a recent meeting, the committee chose a few foreign corresponding members, including George M. Trevelyan (England), Professors Harnack and Delbrück (Germany) and William Roscoe Thayer (United States).

The Smithsonian Institution has published a "Bibliography of Aeronautics," which has been issued as volume 55 of the Smithsonian Miscellaneous Collections. Nearly one thousand pages are required to present the 13,500 references which have been arranged alphabetically by authors, subjects and titles covering the subject down to July, 1909. Mr. Paul Brockett, the assistant librarian of the institution, is the compiler, and in his introduction he reviews the long association of the institution with aeronautics, pointing out that as early as 1861 assistance was solicited for carrying out experiments to cross the Atlantic by means of a balloon. Two years later there were published by the institution two papers on the general subject of aeronautics and since then thirty-five publications on various phases of the subject have been issued. In greater detail Mr. Brockett reviews the con-

tributions of Secretary Langley. He tells of the publication of his "Experiments in Aerodynamics" in 1891 and then of his further technical contribution on "The Internal Work of the Wind" in 1898. Very briefly is the story told of Langley's two flights with heavier-than-air machines.

SOME time ago an International Commission for the study of the effect of high altitude and solar radiation on medical and biological conditions was constituted, and Professor Pannwitz, of Charlottenburg was appointed president. We learn from the *British Medical Journal* that the commission has selected the Peak of Teneriffe as the site of its investigations. In view of the favorable conditions obtaining in the Canary Islands, and especially at the spot chosen, it was felt that it would be wise to study meteorological and astronomical as well as biological and medical problems. Professor Hergesell, the president of the international commission for scientific aerology, joined in the project, and when the observatory on the Peak of Teneriffe was opened, the German emperor presented the commission with a transportable house. On March 12 Professor Pannwitz started from Southampton with the members of the expedition, including Professor Barcroft and Dr. Douglas, of Cambridge, Professor Zuntz, of Berlin, and Dr. Neuberg, Dr. J. Mascat, Dr. Plasse (France), and Professor During and Professor H. von Schrötter, of Austria. The program includes the study of the effect of solar radiation (heliotherapy) in the treatment of pathological conditions; the continuation of the researches on biological processes at high altitudes, commenced by Professor Zuntz on Mont Rosa; and further observation of Halley's comet. A certain amount of preliminary work in meteorology has already been undertaken by Professor Hergesell and his assistants, and in this work the Prince of Monaco has materially assisted by lending his yacht, and by supporting the observatory in many ways. The Peak of Teneriffe offers special advantages for astronomical observations. The clear atmosphere at the peak, which is situated well above the cloud line and stands some 7,000 feet above the sea, renders the observatory a suitable place for studying the comet. The Spanish government has shown its interest by undertaking to extend the observatory, and has provided it with telegraphic communication.

PLANS have been adopted for the conduct of the Phipps Institute, now a department of the University of Pennsylvania, which we quote from the *Journal* of the American Medical Association. The work has been planned by a committee of physicians, comprising Drs. John H. Musser, David L. Edsall, Alexander C. Abbott and Charles H. Frazier. As soon as possible the new building will be erected at Seventh and Lombard Streets, the site first bought by Mr. Henry Phipps, and architects are now at work on the plans and specifications. It will be the most complete hospital for the treatment of consumptive patients in the United States. The trustees have elected the following men to direct the work of the institution: Director of the laboratory, Dr. Paul Lewis; director of the clinical department, Dr. Henry R. M. Landis, and director of the sociologic department, Alexander Wilson, who will be superintendent of the institute and with the director tor of the laboratory will devote all his time to the work. It has been decided to appropriate $5,000 for the maintenance in the laboratory work the first year and $1,800 for the clinical department. For the sociologic department the first appropriations will include $500 for an assistant to the superintendent; $2,300 for out-patient nurses; $1,200 for educational work, and $3,900 for emergency and special expenses. The institute will be governed by a board of directors composed of eight members, of which Provost C. C. Harrison, of the university, will be president ex-officio. The other members included the three heads of the institute and the following: Dr. John H. Musser, for medical council; Dr. Robert G. LeConte, of the board of trustees; George E. Gordon, representing the donor, and Dr. Charles J. Hatfield, of the Pennsylvania Society for the Prevention of Tuberculosis. Members of the advisory council, who

will hold a meeting once a year, are as follows: Pathological Department—Dr. William H. Welch, Baltimore; Dr. Theobald Smith, Boston; Dr. H. Gideon Wells, Chicago; Dr. Simon Flexner, New York. Clinical Department—Dr. James A. Miller, New York; Dr. Lawrason Brown, Saranac Lake, N. Y.; Dr. Joseph Pratt, Boston; Henry Baird Favill, Chicago. Sociologic Department—Dr. Samuel McC. Lindsay, New York; William H. Baldwin, Washington; Dr. Herman M. Biggs, New York; Dr. Samuel G. Dixon, Harrisburg, Pa.

UNIVERSITY AND EDUCATIONAL NEWS

Announcement is made of the receipt by Western Reserve University of a gift of $250,000 by Mr. H. M. Hanna, as an addition to the endowment of the medical department. The income from this gift is to be largely used in the clinical departments to enable the school to put these departments upon a university basis.

Mr. J. Ogden Armour has made a gift of $70,000 to the Armour Institute of Technology.

Dr. Roscoe Pound, who has successively held chairs of law at the University of Nebraska, Northwestern University and the University of Chicago, has been appointed Story professor of law in Harvard University. Dr. Pound was for many years director of the Nebraska Botanical Survey and is well known for his contributions to botany.

Professor Alexander S. Langsdorf has been appointed dean of the school of engineering of Washington University, to succeed Professor Calvin M. Woodward. Professor Langsdorf will continue in active charge of the Department of Electrical Engineering.

At the annual meeting of the regents of the University of Nebraska Adjunct Professor Walker and Adjunct Professor Pool, of the department of botany, were promoted, with the title of assistant professor of botany. Professor Pool was made curator of the university herbarium, also, and to Professor Walker's duties were added those of keeper of the botanical library.

At Cornell University instructors have been appointed as follows: M. M. Goldberg, in physics (promoted); Fred MacAllister, in botany; H. W. Mayes and M. H. Givens, in physiology and biochemistry (promoted).

Dr. M. Verworn, professor of physiology at the University of Göttingen has been called to Bonn to succeed the late Professor Pflüger.

DISCUSSION AND CORRESPONDENCE

ON THE APPARENT SINKING OF SURFACE ICE IN LAKES

To the Editor of Science: During the disintegration of the surface ice in a lake in the spring it is a matter of common observation by the natives that the ice suddenly appears to sink, the surface of the lake becoming clear in a few hours. The explanation of this apparent anomaly was difficult to find until it became clear to me as a result of a careful study of the effect of water temperatures in the St. Lawrence River on the growth and decay of ice. The ice sheet which forms on the surface of quiet water becomes thicker on the underside only by the conduction of heat. The total thickness of the ice which will form in a single winter depends not only on the mean air temperature measured in degrees, but on the mean water temperature measured in thousandths of a degree above or below the freezing point.

From measurements made with my special micro-thermometer I have found that the temperature of the water just under the surface ice in a lake or deep river is usually one or two hundredths of a degree above the freezing point, due to the lower layers of warmer water.

In the spring this temperature is considerably higher and the effect of the warmer underwater rapidly honeycombs the ice, thus assisting the sun when the surface snow is absent. In a flowing river the effect of wind and current is to loosen the ice and it is soon carried down by the stream. In a quiet lake

the honeycombed ice remains intact and becomes nothing more than a collection of vertical ice needles ready to topple over at the slightest touch. Outwardly this sheet of instability appears firm and compact. During the period of rotting the temperature of maximum density is slowly advancing upwards towards the ice sheet. Below the surface of maximum density convection of heat brings more and more warm water up from the bottom. There must be then a definite surface in the water at 4° C., below which the temperature is kept fairly uniform by convection and above which there is no movement in the water to disturb the existing temperature gradient up to the ice sheet. As soon as the 4° surface reaches the under side of the already honeycombed ice the change of temperature and movement of water must be fairly sudden, causing a rapid collapse of the whole structure. This no doubt accounts for the characteristic rattling noise when the phenomenon takes place. The ice needles soon melt in the warm water, which gives rise to the general belief that the ice sinks.

H. T. BARNES

MCGILL UNIVERSITY,
April 16, 1910

PLANKTON

THE article of Professor Chas. E. Woodruff in SCIENCE of April 22 recalled to me observations I had made of phosphorescence of the sea. In connection with astronomic work I have sailed many seas, and have circumnavigated the globe in completing its astronomical girdle in longitude.

In the waters along southeastern Alaska, an area of fog, rain and little sunshine, I had observed most exquisite phosphorescence of the sea. When being rowed from the government steamer ashore, every dip of the oars showed them surrounded by that delicate bluish light of phosphorescence. When I walked over the beach of the receded tide every footprint was a blaze of this same light.

Some years subsequently when I started on my work round the world I looked forward with pleasure to beholding the grand phosphoresence of the tropics, under the belief that in the warmer waters and bright sunshine, the plankton—the cause of the phosphorescence—would be more densely distributed. In this however I was sadly disappointed.

In none of the tropical seas did I see any phosphorescence that could at all compare with what I described above. In vain have I stood at night at the bow or side of the steamer on a smooth sea watching for a fine display of phosphorescence. Now and then the comb of the small wave as the vessel parted the waters showed a fringe of the bluish light, and nothing more.

Arrhenius in his "Lehrbuch der Kosmischen Physik," p. 376, says that the phosphorescence of the sea "is most beautifully developed in the tropics," which is not my experience. Major Woodruff's explanation and application to the tropics of the destructive and lethal effect of light on the plankton agrees very well with my observations on the phosphorescence of the sea in different parts of the world.

OTTO KLOTZ

OBSERVATORY, OTTAWA,
April 28, 1910

ATHANASIUS KIRCHER AND THE GERM THEORY OF DISEASE

IN reference to Dr. Riley's note in SCIENCE for April 29, I am glad to make a prompt *amende honorable* for a hasty error of commission in regard to the magnifying power of Leeuwenhoek's microscopes, but it is difficult to see how any injustice has been done to Athanasius Kircher thereby, since the quality of his magnifying glass seems principally a matter of conjecture. If we accept Osler's adjustment of the matter of priority in the bacterial theory of infectious diseases, then the medical fame of the remarkable priest who was also a mathematician, physicist, optician, pathologist, Orientalist, musician and virtuoso, rests rather upon his seven experiments upon the nature of putrefaction[1] than upon his

[1] "Kircher Scrutinium," Romæ, 1658, caput VII., pp. 42–49.

central thesis: *Quod ex putredine perpetuo corpora quædam insensibilia in circumsita corpora exspirentur, quæ effluvia pestis seminaria dicuntur,*[2] the terminology of which immediately suggests the excerpts I have given from Fracastorius.

Kircher's "Scrutinium pestis," one of the acknowledged landmarks in medical progress, was published in Rome in 1658, at least seventeen years before Leeuwenhoek's discovery of the infusoria (1675) and twenty-five years before his Royal Society paper on the microorganisms found on the teeth (September 17, 1683); so that making every allowance for the skill and proficiency of seventeenth century opticians in grinding and polishing lenses, the question whether Kircher's lenses were better or worse than Leeuwenhoek's is one of those "improbable problems" that each one can settle according to his personal preferences. No one will deny that Kircher saw some minute organisms under his glass, but my quotation from Puschmann's "Handbuch" to the effect that this glass was "only a 32-power at best" was, I think, taken from a most authoritative source, Loeffler's "Vorlesungen," and certainly between this statement and Kircher's own romantic assertion that his lenses magnified a thousandfold, there is opportunity for extreme latitude of opinion. If Kircher's microscope still exists, say in the Vatican collection or any other collection left by him, the point might perhaps be settled by having the lenses examined.

Leeuwenhoek's paper of 1683[3] contains what appear to be accurate figurations of chains of bacilli as well as of individual spirilli and bacilli, and I am informed by a competent bacteriologist that it would be perfectly possible to see such chains and clumps with an occasional motile specimen through a glass of the power specified by Dr. Riley. All honor then to the father of microscopy, who, if he saw bacteria without staining methods, showed himself a genuine laboratory worker, by also drawing them. But neither the notations of Leeuwenhoek, nor the labors of Müller, Ehrenberg, Cohn and Nägeli, can compare with the gigantic strides made by Pasteur, who, as Virchow once passionately declared,[4] was the first to handle the bacterial theory of infection in "the grand style" (*im grossen Styl*), and thence to attempt a working theory of immunity and a practicable enlargement of Jenner's scheme of preventive inoculation. It is this that gives Pasteur his fixed and unassailable position as the true founder of bacteriology—at least so far as the history of medical science is concerned.

In reference to Dr. Henry Skinner's note on the mosquito theory of yellow fever,[5] I have been reminded by Professor Osler that there are authorities recently cited by Boyce[6] "that quite put Finley in the shade." Of these the claims of Dr. J. C. Nott (1848) have not been disputed, while a paper by Louis-Daniel-Beauperthuy, published in the "Gaceta Oficial de Cumana" (1853) is probably the best early contribution extant on the mosquito theory, containing a remarkably clear perception of the hæmolysis produced by toxins and venoms, and a clever note on the characteristic striped legs of the yellow fever mosquito (*Stegomyia calopus*).[7]

That the deductive theorists of one generation should rest upon the shoulders of their predecessors seems natural if we consider that only inductive demonstrations, like those of Harvey, Pasteur, Lister, Reed and Carroll, constitute real tangible proofs. The kinetic theory

[2] *Ibid.*, 29.

[3] A. Leeuwenhock, "Ontledingen en Ontdekkingen," Leiden, 1696, 1. Stuk, pp. 12–15; the cut on p. 13 is reproduced by Loeffler and in Jordan's "General Bacteriology," Philadelphia, 1909, p. 18.

[4] "Wenn man jetzt auch darüber streitet, wer die ersten waren, welche diesen oder jenen Gedanken entwickelt haben—das kahn Niemand im Abrede stellen: Pasteur ist es gewesen, der im grossen Styl die Frage von der Uebertragung der Krankheiten durch bestimmte infectiöse Körper in die Hand genommen hat, und der darauf hin die Immunitätslehre zu begründen gesucht hat." Rudolf Virchow, *Verhandl. d. Berlin. med. Gesellsch.*, 1895, XXVI., 161.

[5] SCIENCE, April 22.

[6] Sir R. W. Boyce, "Mosquitoe or Man?" London, 1909, 23–28.

[7] *Ibid.*, 24–25.

of gases, one of the greatest modern physicists informs us, is "lost in antiquity." The atomic theory of matter is accurately stated in the "De rerum natura" of Lucretius, who got it from its Greek author Democritus; and Lord Kelvin, in his ingenious essay "Æpinus atomized," has indicated that the essential features of the electronic theory of matter had already been stated over a hundred years before, by the Rostock physicist Franz Hoch (1759). Who can doubt that the Greek scientists owed much to the learned Orientals and Egyptians who preceded them? We may take comfort then in the shrewd observation of the author of "Hudibras" that the speculative theorist is often several generations behindhand:

"For Anaxagoras long agone,
Saw hills, as well as you, in the moon;
And held the sun was but a piece
Of red hot iron, as big as Greece;
Believ'd the heavens were made of stone,
Because the sun had voided one;
And, rather than he would recant
The opinion, suffered banishment."

F. H. GARRISON

ARMY MEDICAL MUSEUM

A COMMENT ON ASPHYXIA

SOME surprising material is contained in Dr. John Auer's reply[1] to a note on the "Effect of Asphyxia on the Pupil," by A. H. Ryan, F. V. Guthrie and myself.[2] As he does not present any evidence against, nor even deny the accuracy of our observations on, the phenomenon to which we recalled attention by the statement that as a rule a very marked constriction of the pupils occurs in an early stage of asphyxia, no reply is necessary.

But since he attempts to account for our statement by saying that had we pushed our experiments further we "would have found the marked dilatation of the pupil which occurs in mammals during the second and third stages of asphyxia," as the senior author of the note I feel it incumbent upon me to make certain statements in order that those not thoroughly conversant with the subject may not receive erroneous impressions regarding the phenomena of asphyxia on the pupil.

[1] SCIENCE, N. S., 1910, XXXI., 578.

[2] SCIENCE, N. S., 1910, XXXI., 395–396.

It would seem that the classical phenomena of asphyxia are too well known to require mention, but in view of the above, I will here give an elementary statement of them taken from Starling,[3] to whom we referred in our communication:

The phenomena of asphyxia may be divided into three stages:

1. In the first stage, that of hyperpnœa, the respiratory movements are increased in amplitude and in rhythm. This increase affects at first both inspiratory and expiratory muscles. Gradually the force of the expiratory movements become increased out of all proportion to the inspiratory, and the first stage merges into:

2. The second, which consists of expiratory convulsions, in which almost every muscle of the body may be involved. Just at the end of the first stage consciousness is lost, and almost immediately after the loss of consciousness we may observe a number of phenomena extending to almost all the functions of the body, some of which have been already studied. Thus at this time the vasomotor center is excited, causing universal vascular constriction. There is often also secretion of saliva, inhibition or increase of intestinal movements, *constriction of the pupil*,[4] and so on.

3. At the end of the second minute after the stoppage of the aeration of the blood, the expiratory convulsions cease almost suddenly, and give way to slow deep inspirations. With each inspiratory spasm the animal stretches itself out, and opens its mouth widely as if gasping for breath. The whole stage is one of exhaustion; *the pupils dilate widely*,[4] and all reflexes are abolished. The pauses between the inspirations become longer and longer, until at the end of four or five minutes the animal takes its last breath.

Therefore, the implication that we were not aware that dilatation of the pupil occurs in a later stage of asphyxia is unworthy of further mention. Nor need any attention be paid to the term "original communication" applied to our note, for by this fact alone he shows that he had not read it even with

[3] "Elements of Human Physiology," 1907, 8th edition, pp. 404–405.

[4] Italics mine.

casual care. For therein we specifically stated that notwithstanding the fact that we could find no comprehensive treatise on this phenomenon in the sources at our command, still we had the impression that very thorough observations have long since been made and recorded, but felt justified in recording our observations in order to *recall* attention to the phenomenon. So, notwithstanding Dr. Auer's conviction to the contrary, I still hold that the material contained in our communication is not original.

Finally, had Dr. Auer made careful observations upon the frog's pupil he would have found that excision of the eye or stoppage of the frog's circulation, as by removing or tying off the heart, are alone followed by very marked asphyxial constriction of the pupil, and therefore the employment of additional asphyxial procedures is entirely superfluous. His conclusion might then well have been *that asphyxial changes in a frog's pupil differ from those in mammals in that there is not such a well-marked period of asphyxial pupillary dilatation.* It should be observed that we pointed out in our note that the post-mortem condition of the pupil in different mammals varies: in cats it is chiefly dilatation; in common gray rabbits constriction (as compared with the size of the normal pupil in diffuse daylight). From this it is obvious that the asphyxial changes in the frog's pupil as compared with those of the rabbit are in general similar, the chief difference being a well-marked but short period of dilatation in the rabbit.

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QUOTATIONS

"MEDICAL FREEDOM"

MAKERS of patent medicines, adulterators of drugs, and practitioners of the cults of mental and osteopathic healing are up in arms. They have persuaded a few well-intentioned but misled individuals to join them, and have formed the "National League for Medical Freedom" to oppose the efforts of practically all the reputable physicians in the country to consolidate the agencies of public health at Washington into one efficient department or bureau.

These efforts have been waxing stronger. The men of the American Medical Association and of the Committee of One Hundred on National Health, sanctioned by the Association for the Advancement of Science and headed by Professor Irving Fisher, of Yale, have won the approval of the entire press of the United States in urging the passage of their bill. In the various departments and bureaus of the federal government are lodged powers that can not be wielded effectively until they shall be coordinated under one head. Once united, they can be used in a great propaganda for educating the people against the habit of self-dosage and a resort to quack medicines for their ailments. By a campaign of prevention the bureau would break the prevalence of epidemics and infections between the states. It would work for the passage of laws that would guard the channels of inter-state commerce against the admission of adulterated drugs, and for the establishment of standards of purity and strength that would be copied by the states and cities of the nation.

The self-styled "League for Medical Freedom" quotes Professor Fisher accusingly as having said that the government might soon be appropriating millions yearly for the conduct of this bureau. If it should appropriate a million for every hundred thousand it now appropriates for the protection of the health of hogs and cattle in the United States, Professor Fisher's prophecy would be fulfilled, and no one would have cause for complaint but these friends of "freedom." Their cry is an old one and well understood.

License they mean, when liberty they cry.—The N. Y. *Times*.

SCIENTIFIC BOOKS

Ants. Their Structure, Development and Behavior. By WILLIAM MORTON WHEELER. New York, Columbia University Press, Macmillan Co., publishers. 1910.

One need not be very old to recall the time when ants were the most neglected of American Hymenoptera. I remember receiving a letter from Dr. W. H. Ashmead, some twenty years ago, in which he urged me to take up the study of ants. The necessary literature he said was not voluminous, material was easily obtained—he himself could supply a large series of species from Florida—and the field was a new and fertile one. Doubtless he urged others in the same manner, always without success. A few American students did a little in a desultory sort of way, but the real authorities on our ants were Europeans, Emery and Forel. Wasps, bees, ichneumons, sawflies, all were being studied and described with zeal; but as for the ants, probably some thought them too difficult, while others supposed they were sufficiently known, and for one reason or another nobody would have anything to do with them.

Although this apathy might well have been regretted then, it is impossible to regret it now. The foundations of American myrmecology had indeed been laid by the Europeans, but the building itself was destined to be erected, in the fullness of time, by an American. Dr. Wheeler published his first contributions to the subject in 1900, and it was at once apparent that the ants had come to their own. Since then he has labored incessantly, issuing several important papers every year, and now a large volume discussing every aspect of the life and structure of his favorites.

It is probably not too much to say that Dr. Wheeler's "Ants" is the best book on entomology ever published in this country. In a certain sense, the general text-books of several eminent authors are much more comprehensive; a mere treatise on ants seems a very limited affair, dealing with merely a fraction of a single order. This *a priori* judgment is quickly dispelled on reading the book. Here we have morphology, anatomy, embryology, psychology, physiology, sociology, paleontology, zoogeography, taxonomy and even philosophy dealt with in an illuminating manner! The ant is presented to us as the hub of the universe, and if there is any biological subject which may not be suggested by the study of myrmecology, it is probably of small consequence. No other entomological author has been in a position to give us a work at once so comprehensive and so critically written. Those who have produced admirable revisions of particular groups, have usually known little about development or habits, and have not so much as seemed aware that their subjects had a past. Those who have tried to cover the whole field, or a large part of it, have been obliged to compile much that could not be critically digested, no man being an expert in the whole of entomology. Such a work as the present may be taken to represent an optimum between two extremes, combining breadth with depth, neither being sacrificed to the other, while all is presented in a lucid and entertaining manner.

It is a model exponent of the new biology, of a method which will, we hope, eventually become as common as it is now rare. It is impossible to give any summary of the contents. Very interesting chapters are those on polymorphism, on harvesting and fungus growing ants, on the extraordinary honey-ants, on the slave-makers of various kinds, and on the numerous insects of different orders living in the nests of ants. The chapters on sensation, instinct and "plastic behavior" constitute a little treatise on psychology.

Dr. Wheeler remarks that three different views may be entertained concerning the behavior of ants: "First, it may be said that ants not only have images or ideas as the result of sensory stimulation, but are able to recall them at will, and to refer them to the past. This would imply that ants, like man, not only have memory, but also recollection. Second, it may be maintained that ants have images only as the result of sensory stimulation, but are unable to call them up at will, much less to refer them to the absent or the past. This would imply that the insects have sensory association, but not recollection. Third, it may be maintained that ants are unable to form images or ideas and are hence

devoid of memory." The third view is said to be wholly untenable, and the second is considered "far and away the most plausible." However, on an earlier page Forel is quoted to the effect that *Polyergus*, after plundering a nest, appears to remember whether any pupæ were left, and in that case returns for them: "memory alone, *i. e.*, the recollection that many pupæ still remain behind in the plundered nest, can induce them to return." This seems to imply the first of the three alternatives, unless we hold that departure from an *empty* nest discharges a psychological state which would otherwise act as a stimulus to return. At all events, Dr. Wheeler has little sympathy with the purely mechanical interpretation of insect behavior. "I have unintentionally sat on nests of *Vespa germanica* and *Pogonomyrmex barbatus*," he remarks, "and while I have no doubt that I myself acted reflexly under the circumstances, it will take quite an army of physiologists to convince me that these creatures were acting as nothing but reflex machines."

At the end of the chapter on the degenerate slave-makers there is a bit of sociology which is worth quoting:

> The zoologist, as such, is not concerned with the ethical and sociological aspects of parasitism, but the series of ants we have been considering in this and the four preceding chapters can not fail to arrest the attention of those to whom a knowledge of the paragon of social animals is after all one of the chief aims of existence. He who without prejudice studies the history of mankind will note that many organizations that thrive on the capital accumulated by other members of the community, without an adequate return in productive labor, bear a significant resemblance to many of the social parasites among ants. This resemblance has been studied by sociologists, who have also been able to point to detailed coincidences and analogies between human and animal parasitism in general. Space and the character of this work, of course, forbid a consideration of the various parasitic or semi-parasitic institutions and organizations—social, political, ecclesiastical and criminal—that have at their inception timidly struggled for adoption and support, and, after having obtained these, have grown great and insolent, only to degenerate into nuisances from which the sane and productive members of the community have the greatest difficulty in freeing themselves.

Not many adverse criticisms occur to one and these relate only to minor details. I have found some practical inconvenience from a lack of connection between the illustrations and the text. In some cases the illustrations (*e. g.*, those of *Leptanilla* on p. 262) arouse a lively curiosity, and one is disappointed not to find anywhere in the book a suitable explanation of the peculiarities figured. There are some slight errors and misprints, mostly of little consequence; I venture to remark that the bee cited on p. 209 is *Ceratina nanula*, not *nana*. It is rather discouraging to find two figures of *Cremastogaster* nests built round coccids, and not even the genus of the coccid given.

In the chapter on fossil ants, there is a curious quotation from Emery which refers to the ants of Sicilian amber as indicating the condition of things "at the beginning of the Tertiary," and assumes that the Sicilian and Prussian ambers were contemporaneous. As is properly stated on another page, the Sicilian amber is very much later than the Prussian, and neither belongs to the earlier part of the Tertiary. None of the European localities for fossil ants seem to be older than Oligocene, but the American Green River beds are now known to be Eocene, and the two species indicated therefrom by Scudder are apparently the oldest known ants. There is on p. 162 a reference (which I have not followed up) to ants in the amber of Nantucket, "which is attributed to the Tertiary." This should certainly be looked into, as there is a possibility that the amber referred to may be of Cretaceous age.

There are some very useful appendices: (*A*) Methods of Collecting, Mounting and Studying Ants; (*B*) Key to the North American forms, down to the subgenera; (*C*) Complete list of North American (north of Mexico) Ants, with localities; (*D*) Methods of Destroying Ants, and (*E*) a voluminous (though still incomplete!) Bibliography.

T. D. A. COCKERELL

Distribution and Movements of Desert Plants. By VOLNEY M. SPALDING. Carnegie Institution of Washington, Publication No. 113, issued October 22, 1909.

Those who have for some years expected the publication of Professor Spalding's arduous and prolonged studies of the desert vegetation of the southwest, but more particularly in the vicinity of the Desert Botanical Laboratory, welcome it in a peculiar sense of gratification. The work, entitled as indicated above, embraces, to be sure, a wider range of observation than that within the purview of the leading author. The following are the themes discussed: Plant Association and Habitats; Local Distribution of Species, in which Cannon's studies on root distribution are made use of; The Lichens, by Professor Bruce Fink; Environmental and Historical Factors, including the geology and soils of the vicinity of the Laboratory Domain, by Professor C. F. Tolman and Professor B. E. Livingston, respectively; The Vegetative Groups, by Professor J. J. Thornber; The Origin of Desert Flora, by Dr. D. T. MacDougal; followed by a general discussion. This serious attempt to correlate the results of specialists in a vegetational study has everything to commend it, and the results which have emerged fully justify the expectation that this method of procedure will, for the future, serve an increasingly important rôle.

Aside from the hydrophytes, of minor interest in the work before us, the range of biological types found in the Tucson region includes two ecological groups, the xerophytes, generally distributed on the slopes and "mesas" so called, and the mesophytes, which are found especially near the watercourses and, as the result of irrigation, in the flood plains. This distinction in habitat is, however, operative only in general. The shade afforded by other plants and the nooks of sheltering rocks extend, very locally, into the drought period, the mesophytic conditions established by a rainy season. It thus comes about that antithetically pronounced mesophytes and xerophytes frequently stand close together in contingent habitats. It is to be noted, however, that the mesophytic conditions are relative and may not be compared with their analogues in the eastern or northern United States.

The winter and summer rains produce two mesophytic seasons of varying length, according to the character of the precipitation. These are times of rich vegetation of annuals, which, however, are not common to the two seasons. Thornber, by experiment, has shown that the temperature relations exhibited by the seeds of these annuals are prepotent in fixing their times of germination.

It is noted that the cryptogamic elements of the vegetation are relatively unimportant. The reviewer has had occasion to remark the very striking difference in this regard between the desert about Tucson, and that of north Zacatecas, where the land cryptogams, including algæ, lichens, bryophytes and pteridophytes are much more in evidence. This difference may be charged to a lower rate of evaporation in Zacatecas, as also may the general as well as local differences in the occurrence of phanerogamic as well as cryptogamic parasites. These, in the Tucson desert, are very inconspicuous; the cases noted by Spalding are *Phoradendron* on the mesquite and a root parasite *Orthocarpus*, studied by Cannon.

The mesquite is recognized as the dominant element in the mesquite forest association of the flood plain. While adapted to low degrees of atmospheric humidity, its demands for soil water are relatively high. Its maximum development is therefore in the flood plain, in which situation its roots are in correspondence with "a sufficient water supply." Its success in maintaining its foothold is attributed to the effective root system "always within reach of a permanent, deep water-supply." The reviewer takes this not of necessity to mean a water table. At any rate, it is certainly known that vast mesquite areas are to be found where no water table has been discoverable within several hundreds of feet. The high capillarity of the very fine, compact, very deep soil of the flood plain is sufficient to explain the presence of the mesquite.

The mesquite occurs also along washes, but

is of smaller size, and still smaller is it when present on the hillsides. The distribution, as indicated by its size, is evidently indicatory of the different amounts of available soil moisture. The reviewer has noted that large mesquite occurs on hillsides in Zacatecas, where there are hidden springs, as indicated by an actual outflow some distance away.

The mesquite in respect to water-supply is a physiological type to which belong, *e. g.*, *Koeberlinia spinosa*, *Holacanthus* sp. The water relations of these plants have given rise to a saying in Mexico: ***Donde hay junco, hay aqua,*** "where the junco occurs, there also is water," upon which faith many a dry well has been dug. This *à propos* of the occurrence of mesquite in the flood plain.

Of the more distinctly desert associations is Spalding's creosote-bush (*Larrea*) association. This is almost coincident with the mesa-like slopes of low gradient so characteristic of desert regions. Untoward physical conditions are here—a soil with little capacity for water retention, and underlaid by an impervious hardpan of caliche. To the most rigorous of these conditions the creosote-bush is the last to succumb, and is often the only plant with a perennial foothold.

The peculiarities of local distribution contingent upon the aspect of slopes, especially the steeper ones, have been extremely well studied by Professor Spalding, and the maps, made in detail and accuracy hitherto unequaled, by Mr. J. C. Blumer, to record observations, rather than merely to illustrate the principles involved, are in themselves a noteworthy contribution. Five species have been thus studied in detail. Of these, the most compelling example, by virtue of its size and appearance, is the sahuaro, *Cereus* (now *Carnegiea*) *giganteus*. This principally affects the southern aspects of the hills, the "optimum physical habitat" for this plant. The author has endeavored in this, as in the other cases treated, to refer this peculiar distribution to an efficient cause or set of causes. The search for these has led Professor Spalding to very important conclusions. Thus, the choice of habitat is, in many cases, conditioned by "difference in habit, and power of accommodation," leading to a fixation in particular situations. On the other hand, some plants are distinguished by a wide capacity for adjustment, and hence the restrictions upon choice of habitat are less strait and insistent. Here is pointed out that physiological adjustment may be of far more importance than structural "adaptation," but it appears—and this is of major importance—that in both cases "inherited peculiarities determine the limits of choice." Apparently the evidence does not indicate a progressive (racial) change in adaptation, but that a chance pre-fitness determines the possibilities of getting along.

Of chief importance appears to be the "range of temperature, though other factors, in certain cases at least, are involved." A constructive criticism at this point may be made that temperatures may be of this degree of importance in only a secondary way, but this also in certain cases. The view seems justified that the differences of insolation, and so of the temperatures, on slopes of opposite aspect, is effective in selection as between plants, which, during germination, quickly attain a sufficient (and again inherited) degree of structural or physiological resistance and those which are slow in this regard. The conclusions before us strongly indicate the great importance of the study of seedling development, and it may be believed that much light will thus be thrown on many still obscure questions of distribution.

Nevertheless, Professor Spalding makes a strong case for the direct effect of temperature, as *e. g.*, in the case of the sahuaro, whose limits of distribution appear to be set by temperature limits. It would be of the greatest interest and profit to compare, for this plant, its temperature environment, *e. g.*, in the Sta. Catalina Mountains and those of its present, generally northern, geographical range.

The so well-known individual isolation of desert plants has given force to the idea very generally accepted, that their interrelations are of minor importance. Pause is given to

this view, and while no detailed study is as yet available, it is pointed out that *vigorous competition is the rule and not the exception.* The "mutual accommodation" of certain plants as seen in the non-interference of the root systems (Cannon) is referred to; thus, the proximity of certain species involves the minimum of competition. Accommodation appears to the reviewer, therefore, as to Dr. Cannon, to be a minor degree of competition, or at least involves at some time a struggle. It frequently happens, *e. g.*, that the sheltering protection of an established plant results only in establishing active competition, frequently of minor but often of greater vigor, between it and its protegé. In this connection is of interest an account by Dr. Cannon, of the root system of *Cereus* (*Carnegiea*) *giganteus* and its mutual relations with those of three other species, discovering important topographic differences, which result that the roots of these plants, growing close together, are rarely in physical contact, because, chiefly, they do not occupy the same soil horizon, though "this does not mean that the plant (*Cereus*) is free from competition." It is further developed that the cacti are chiefly characterized by a relatively much more important lateral, shallow root system, and sees in this an important adjustment for aeration, in the absence of foliage, as well as to mechanical support, and for the remarkable readiness with which slight precipitation is made use of.

Professor C. F. Tolman gives an account of the geology of the vicinity of the Tumamoc Hills, where stands the laboratory. Two matters of more general interest emerge, namely, the origin of the wide slopes of gentle gradient, above referred to, and that of the "caliche," the calcareous hard-pan which plays an important rôle in its relation to the vegetation. Professor Tolman contends for the subaerial deposition of the clinoplains (Herrick) or conoplains (Ogalvie) and applies to these the simple, but unfortunately generic name of "slopes," to which the reviewer had previously applied the more specific term, foot-slope. To him—perhaps for human reasons alone—the latter appears the more descriptive and appropriate name. But we are more interested in Professor Tolman's views—concerning the materials composing the slopes. They are derived from the steeper mountain slopes above, which are, under semi-arid conditions, strongly attacked by torrential precipitation. The slope is, as said, of sub-aerial origin, in the formation of which temperature change and gravity play the leading parts, running water bearing "a varying rôle." This view is asserted chiefly for the reason that it controverts an earlier interpretation which calls upon a former marine or lacustrine extension to explain the topographical uniformity of the foot-slopes. Professor Tolman says that "deposition" in the playa is "most active during periods of water occupancy, when the dust from the mountains and slopes is caught by the water sheet." The evaluation of the factors at work is, however, confessedly difficult, but the reviewer suggests that, in undrained playas, the moving water sheet on the lower zones of the foot-slopes and the arroyo-imprisoned streams of their upper zones, consequent on heavy precipitation, are of great importance in eroding and carrying finer detritus to be laid down by the standing water sheet. As a matter of observation, this seems to be an important condition at the present day in certain regions.

The explanation of the caliche—this, Professor Blake's name, is retained—accords, with slight modification, with that of Professor Forbes. Caliche is, according to the latter, a "mixture of colloidal clay and carbonate (mainly) of lime," carried by the rain water downward into the soil to the depth, a few inches to three or four feet, where, as the result of desiccation, the hard-pan is formed. Professor Tolman finds, however, a ready supply of calcareous matter, coupled with an absence of drainage to remove it, to favor the encrustation. The rapidity with which caliche may be formed under experimental conditions out-of-doors may be remarkable—two inches in two years. The body of Professor Tolman's paper treats of the topography, geology and petrography (based on the work of Professor F. W. Guild) of the laboratory domain. This

part the reviewer leaves to a more capable pen. Professor B. E. Livingston contributes a section on the soils of this domain. He describes these soils in some detail, and there follow data derived from a detailed study of the soil moisture content at given depths for a period extended between October 3, 1907, and April 11, 1908. The importance of such information is shown in the fact that the effect of precipitation lags behind the precipitation itself, which "consideration emphasizes the inadequacy of mere precipitation data in any attempt to determine the moisture conditions under which the plants of any region live." Elsewhere, Professor Livingston points out that the "distribution of plant forms is perhaps more often determined by availability of oxygen than that of water," and this is of importance for desert plants, many of which appear to suffer from lack of oxygen in soils too abundantly supplied with moisture. Professor Spalding concludes that the facts established by Livingston show a remarkable degree of correspondence with the facts of distribution.

Professor J. J. Thornber, in a few pages, gives an exceedingly important summary of the vegetation groups of the domain. The unimportance of biennials is remarked, only three species being noted, in contrast to a total of 230 annuals. Of these, the winter annuals are three times more numerous than those of the summer. The total number of perennials is about equal to that of the annuals. Numerically the grasses (70 sp.) and the compositae (65 sp.) are dominant.

Of the lichens, of which at any rate 24 species are reported, enough, based on the study of them by Professor Bruce Fink, is said to indicate that a fruitful field of study awaits one who is disposed to attack these organisms in their desert habitat from an ecological point of view.

Dr. D. T. MacDougal deals trenchantly with the live question of the origin of desert plants. He sees little evidence that individual capacity in the soma has resulted in adaptation to desert conditions. The mesophytic forms which have extended to the desert regions flourish only during the mesophytic periods. Observed responses to true desert conditions are not necessarily adaptive, nor is it possible to refer highly specialized characters to the "supposedly causal conditions which they meet," such as the spines and glochidia of cacti. This is well said.

The weight of experimental evidence, derived from the work of Tower, Gager and MacDougal, the latter especially, indicates that the effects of environmental changes in the germ plasm are accountable for "irreversible changes in a hereditary line by which new combinations of qualities and new characters" become "fully transmissible." Dr. MacDougal properly points out the mental bias which has led to the regarding of desert plants as highly specialized, and mesophytes as not. What would the trained botanist of desert antecedents have thought on viewing, for the first time, a mesophytic forest!

It is clear from this cursory glance at the volume under review, embracing only a few of its more striking features, that a great deal of careful, insistent inquiry has been carried on by all the authors. This, it is equally evident, is leading us steadily in the direction of illuminating generalizations, which express more rational notions about plants than those which have held the botanical mind in thrall for many years. We are getting, as an example, a proper notion of adaptation, by which the word itself is condemned. This notion is not new, but is widely unaccepted in practise as yet, and this is well enough if it forces us to bring about an adequate investigation of the facts.

Much remains to do, or, better, shall we say truth if we admit that even the beginnings yet made are small. But beginnings in the right direction are notable, and Professor Spalding's work is such. The reviewer avows his warm admiration and regard for him who, after many years of rare service as a teacher, has devoted much of his remaining strength to a trying field of research, fruitful of basic truth in method and result.

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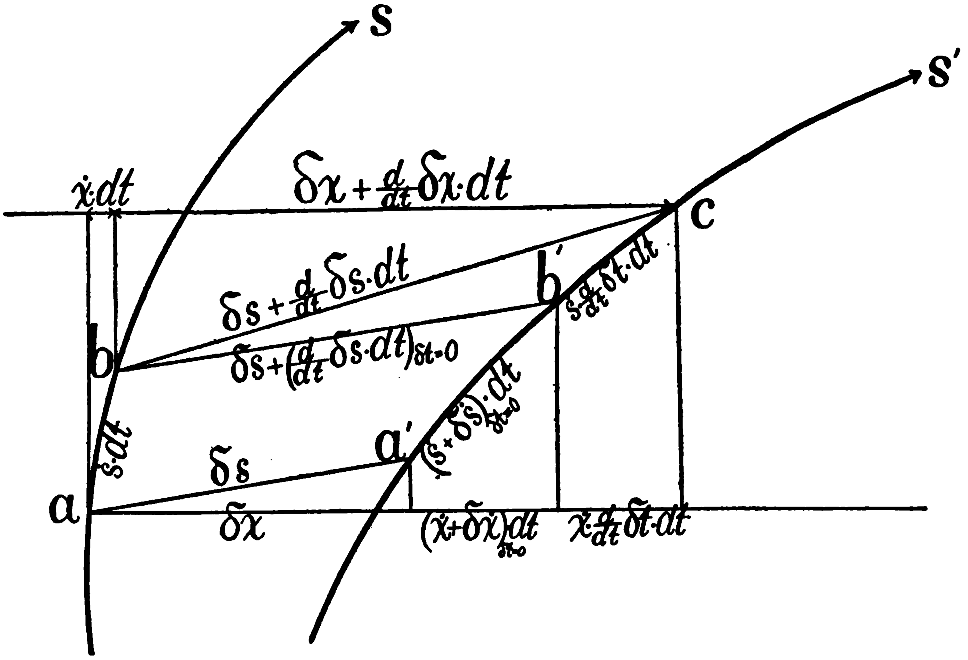
SPECIAL ARTICLES

VARIATIONS GRAPHICALLY

THE usual developments by which the calculus of variations is rigorously established, however cumbersome, are nevertheless satisfactory in so far as the reader knows what the aim is. But with a student, as a rule, they remain hazy. He acquiesces, of course, but he loses faith and the cloud may not be lifted during the whole of his subsequent course in the motion along it. Any two points, a and a', b and b', may therefore be regarded cotemporaneous at pleasure. We may express this by putting $\delta t = 0$, as in the figure. Any variation is possible, but the motion along s' must nevertheless be regarded as continuous; *i. e.*, the experimental motion is conceived as taking place, any assistance from without being admitted. The figure then shows at once, if we pass from a to b' in the two ways,



dynamics. I may therefore ask for indulgence if I publish the following simple treatment, because it has borne fruit and is intelligible to anybody who understands the equation $s = vt$.

Let s be the curve along which the motion of a particle actually takes place. Suppose it is to our advantage to consider what would happen if the motion proceeded along any other infinitely near curve s', selected at random but with the object stated. The notation would be less cumbersome without the differential coefficients $\dot{x}$, etc., but it is more direct to use them.

1. $\delta t = 0$. There are two cases. In the first, the curve s' is quite arbitrary, and so is

$$\delta x + (\dot{x} + \delta\dot{x})\,dt = \dot{x}dt + \delta x + \frac{d}{dt}\delta x \cdot dt,$$

or

$$\delta\dot{x} = \frac{d}{dt}\delta x \qquad (1)$$

the obvious meaning of the last equation.

2. δt *not zero.* In the second case the path s' is still arbitrary, but it may be regarded as a smooth wire along which a bead of the given mass slips by the same forces that move it naturally and without the wire along s. The two motions here are necessarily continuous and both are prescribed. Hence cotemporaneous points a and a', b and b', are prescribed, and an interval of time δt must elapse

in the second case if bc is to be any arbitrary displacement comparable to bb' above, § 1.

If aa' are chosen cotemporaneous, since both motions are continuous, the rate at which the interval will grow from nothing at a to δt at c, dt second later is

$$\frac{d}{dt}\delta t;$$

and the distance passed along the curve in this time excess,

$$\frac{d}{dt}\delta t \cdot dt$$

is therefore

$$\dot{x}\left(\frac{d}{dt}\delta t\right)dt$$

as the figure shows. Hence obviously as before

$$\delta x + (\dot{x} + \delta\dot{x})dt + \dot{x}\frac{d}{dt}\delta t \cdot dt = \dot{x}dt + \delta x + \frac{d}{dt}\delta x \cdot dt,$$

or

$$\frac{d}{dt}\delta x = \delta\dot{x} + \dot{x}\frac{d}{dt}\delta t. \qquad (2)$$

It is also obvious that if we sum up the increments vectorially, from a to c in the two directions the same proposition will hold with regard to s;

$$\frac{d}{dt}\delta s = \delta\dot{s} + \dot{s}\frac{d}{dt}\delta t.$$

3. The important transformation

$$\frac{d}{dt}(\dot{x}\delta x) = \ddot{x}\delta x + \dot{x}\frac{d}{dt}\delta x$$

by which one passes from D'Alembert to Hamilton or to least action, respectively (see Webster's "Dynamics," which, by the way should be the text-book of every American university, patriotic or not), is a mere interpretation of the last term by the aid of equation (1) in the first case, of equation (2) in the second.

Finally with regard to variations in general it is clear that if ϕ is to have but one value at each point in space and is to vary at a single definite rate in each direction from that point, it is immaterial whether one uses the differentials, dx, dy, dz, meaning thereby that in a complete differentiation we must get back to the initial surface or region $\phi = c$; or the variations δx, δy, δz, meaning that, in general, our progress may terminate in any infinitely near region $\phi = d$, at pleasure, the same differential coefficients must be used. For along x, ϕ can not vary in any other way than at a rate, $\partial\phi/\partial x$, whether our absolute progress is to be dx or δx.

All this is simple enough, but with my students it has made the difference between the spiritless acceptation of what somebody else is supposed to understand and the satisfaction of an actual grasp of the subject.

C. Barus

Brown University,
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MOSQUITO HABITS AND MOSQUITO CONTROL

Until recently it was the general impression that all mosquitoes are blood-suckers and essentially alike in habits. Since the discovery of their relation to disease mosquitoes have been extensively studied, both systematically and biologically. While the study of mosquito biology has not by any means kept pace with the systematic work, a great deal has been learned about mosquito habits and it is now clear that there is great diversity of habits within the group.

To any one who has followed the literature, or become directly acquainted with the remarkable specializations in mosquito habits, it must be obvious that no control work can be carried out successfully and economically without intimate knowledge of the habits of these insects. Many persons, however, who are concerned with mosquitoes in a practical way, either directly in control work or as its advocates, have failed to appreciate this and hold the antiquated ideas. Work done on such a shallow basis must in many cases end in failure and disappointment.

Two striking examples, which have recently come to my notice, illustrate very well how such shortcomings lead to error. Sir Rubert W. Boyce, dean of the Liverpool School of Tropical Medicine, is the author of an interesting and excellent work which appeared recently under the title "Mosquito or Man?" While the book is written on broad lines it nevertheless contains specific statements, and

from such an author they command respect and are sure to be widely quoted. On page 96 we find this assertion:

In many of the more low-lying swampy coasts crab-holes occur in enormous numbers in the sandy soil, and in them are bred vast numbers of mosquitoes. In fact they constitute the chief nuisance in those houses which are situated near the sea.

The region in question is the tropical American littoral and the mosquitoes concerned are the species of the genus *Deinocerites* and certain species of *Culex*, all of which breed exclusively in crab-holes. I can myself testify to the abundance of these mosquitoes in their very restricted habitat, but must challenge the learned author's statement that these mosquitoes are offensive in the manner he indicates. Even where their breeding places are in close proximity to houses these mosquitoes do not enter, much less bite. Out of hundreds of specimens, collected by ourselves and received from correspondents, not one shows traces of a blood-meal, nor have we been able to observe that they are in the least attracted to human beings. On the other hand, we have female specimens of *Culex extricator*, one of the crab-hole species, in which the abdomen, distended with food, is of a pale amber color, showing that the food taken was not vertebrate blood.

Such error, however, does no harm beyond the useless expenditure entailed in the destruction of these inoffensive insects. In the case of the control of the yellow-fever mosquito a wrong assumption becomes a more serious question. The Sanitary Department of the Isthmian Canal Commission deserves great credit for its effective work in the control of this mosquito, and it is primarily the thoroughness of this work that is making possible the rapid progress in the construction of the Panama Canal. The report of the Department of Sanitation for January, 1910, gives brief data on the character of this work and the gratifying results achieved in the reduction of this mosquito.

There can be no doubt that the yellow-fever mosquito has been reduced below the danger-point within the Canal Zone, a thing made easily possible by its habits of close association with man. The implied claim, however, that this mosquito has been eradicated from certain localities within the zone can hardly be accepted upon the evidence presented. This consists of a faulty experiment based upon the erroneous idea that the yellow-fever mosquito normally lays its eggs upon the surface of the water.

At the native town in Gorgona wooden tubs with water were put under the houses on November 6, 1909, and between that time and January 6, 1910, no *Stegomyia* eggs were deposited. Had *Stegomyia* been present, eggs on the water surface would probably have been found.

The inference is that, because no larvæ appeared in the tubs and no eggs upon the surface of the water, no yellow-fever mosquitoes could be present in that locality. Such, however, is not the normal habit of oviposition of this mosquito. The eggs are deposited out of the water, at the edge of the water-film; here the eggs remain until they are submerged, when they promptly hatch. Eggs remaining out of the water retain their vitality a long time. In laboratory experiments eggs have been kept dry as long as five months and, when then submerged, produced larvæ; under favorable conditions out-of-doors it is to be supposed that they will survive even longer. Under the domestic arrangements of the more primitive tropical homes the conditions are ideal for the multiplication of this mosquito. The water receptacles in common use, which are the ordinary breeding places of this mosquito, are seldom, if ever, completely emptied; water is added from time to time, and thus whenever the water level is raised eggs can hatch. It will be readily seen that in the experiment quoted above eggs of the yellow-fever mosquito might easily have been present but could not have hatched, as the water in the tubs remained undisturbed.

Frederick Knab

THE AMERICAN PHILOSOPHICAL SOCIETY

The general meeting of the American Philosophical Society was held in the hall of the society, Independence Square, Philadelphia, on Thursday,

Friday and Saturday, April 21, 22 and 23. The session was opened on Thursday at 2 P.M. by the president, Dr. W. W. Keen, who occupied the chair throughout the meetings except at the afternoon session of Friday, which was presided over by Vice-President Professor William B. Scott, and the session of Saturday morning, when Vice-President Professor Edward C. Pickering presided. The afternoon of Saturday was devoted to a symposium on "Experimental Evolution," the principal papers being given by Herbert S. Jennings, professor of experimental zoology in Johns Hopkins University, on "Inheritance in Non-sexual and Self-fertilized Organisms"; George H. Shull, resident investigator, Station for Experimental Evolution, Carnegie Institution, Washington, on "Germinal Analysis through Hybridization," and Charles B. Davenport, director of Station for Experimental Evolution, Carnegie Institution, on "New Views about Reversion." Professor William L. Tower, of the University of Chicago, was also to have contributed a paper, but was prevented from attendance. After the principal papers, a number of other members participated in the discussion.

At the session on Saturday morning Professor C. L. Doolittle read an obituary notice of Simon Newcomb, late vice-president of the society, and presented a portrait of Professor Newcomb contributed by members of the society. The portrait was accepted by Vice-President Pickering.

On Friday evening a reception was held at the hall of the College of Physicians, at which Professor George E. Hale gave an illustrated lecture on the Mount Wilson Solar Observatory, describing the instruments and observations carried on at the observatory and at the laboratory in Pasadena connected with it. The session closed with an annual dinner held at the Bellevue Stratford on Saturday evening, April 23. About ninety members were present. At this dinner the toasts were as follows: "Benjamin Franklin," by Charles Francis Adams, Esq.; "Our Sister Societies," by President Ira Remsen; "Our Universities," by President James B. Angell; "The American Philosophical Society," by Dr. James W. Holland.

At the session on Friday morning the following were elected to membership:

Residents of the United States.—Simeon Eben Baldwin, LL.D., New Haven, Conn.; Francis G. Benedict, Ph.D., Boston, Mass.; Charles Francis Brush, Ph.D., LL.D., Cleveland, Ohio; Douglas Houghton Campbell, Ph.D., Palo Alto, Cal.; William Ernest Castle, Ph.D., Payson Park, Belmont, Mass.; George Byron Gordon, ScD., Philadelphia, Pa.; David Jayne Hill, LL.D., American Embassy, Berlin; Henry Clary Jones, Ph.D., Baltimore, Md.; Leo Loeb, M.D., Philadelphia, Pa.; James McCrea, Ardmore, Pa.; Richard Cockburn Maclaurin, F.R.S., LL.D. (Cantab.), Boston, Mass.; Benjamin O. Peirce, Ph.D., Cambridge, Mass.; Harry Fielding Reid, Ph.D., Baltimore, Md.; James Ford Rhodes, LL.D., Boston, Mass.; Owen Willans Richardson, M.A. (Cantab.), D.Sc. (Lond.), Princeton, N. J.

Foreign Residents.—Adolf von Baeyer, Ph.D., M.D., F.R.S., Munich; Madame S. Curie, Paris; Sir David Gill, K.C.B., Sc.D., LL.D., F.R.S., London; Edward Meyer, Ph.D., LL.D., Berlin; Charles Emile Picard, Paris.

In addition to the symposium on "Evolution," fifty-one papers were presented. A list of these with a brief summary of their contents follows.

The Great Japanese Embassy of 1860; The Forgotten Chapter in the History of International Amity and Commerce: PATTERSON DUBOIS, Philadelphia.

An account of this embassy and especially of its visit to the Philadelphia mint and investigation of our system of coinage, etc.

The Government of the United States in Theory and in Practise: C. STUART PATTERSON, Philadelphia.

The federal government has taken a highly centralized form very different from the ideals of the founder of the republic and at variance with the early theory of the balance of power between national government, state and citizen.

On some Philosophical Ideas in Zoroastrianism: A. V. WILLIAMS JACKSON, New York. (Read by title.)

Magical Observances in the Hindu Epic: E. WASHBURN HOPKINS, New Haven.

The practise of magic and recognition of its effects as portrayed in literature, notably in the epic, as contrasted with hymns and magic rules, which inculcate the rites only, formed the subject of this paper. Hindu literature has a number of works in which magic formulæ are given and hymns evidently written for the purpose of magic; but in the Hindu epic literature we see the application of these rules and hymns, and the magic which elsewhere is taught is here actively employed. One of the chief fields of application of magic in a war-epic is naturally that of magic weapons. The idea underlying magical weapons is identical with that of the savage of Australia.

By means of a mystic word, an ordinary weapon becomes bewitched and acquires supernatural power. Magic in sacrifice was shown to lead to human sacrifice, that out of the dead new life might arise. Water-magic was shown to result in the Hindu custom of touching water in making a vow, etc. The evil eye was found to be an article of faith with all the epic characters; also the belief in the king's healing touch, etc. The paper took up, one by one, all the observances noticed in the great epic, which is seven times as long as the Iliad and Odyssey put together.

The Bearded Venus: MORRIS JASTROW, Jr., Philadelphia.

In a hymn to the goddess Ishtar, the expression occurs that "she is bearded like the god Ashur." On the basis of this phrase, the conclusion has been drawn that the Babylonians and Assyrians conceived of Ishtar as both male and female.

It appears, however, that in astrological texts the planet Venus, who is identified with Ishtar, is frequently described as having a "beard"; and it is evident from the connection in which this phrase is used, as well as from explanatory remarks added in the astrological texts in question, that the reference is either to the brilliant, sparkling appearance of the planet or to the blurred appearance which suggests the rough fringes of a beard. The phrase in the hymn to Ishtar, therefore, is based upon the metaphor used of the planet Venus, and as the further context of the hymn shows, is intended to convey the idea that Ishtar is as "brilliant" as the solar god, Ashur.

The second part of the paper was devoted to an investigation of the evidence for a bearded Venus among the Greeks and Romans. It was shown that most of the passages upon which such an hypothesis was based were capable of a different explanation. So, for example, the statement of Herodotus that the priestess of the war goddess of the Carians (whom Herodotus identified with Athene), grows a beard when hostilities are brewing, evidently refers to a prevailing custom, according to which the priestess puts on a beard in order to emphasize, in accord with the principle of sympathetic magic, the hope that the war goddess will manifest her power and strength. The beard in this case is the symbol of the warrior, and it may be that the significant passage in Servius, who states that there was an image of a bearded Venus in Cyprus, is to be explained by some similar custom.

The conclusion reached by Professor Jastrow was that it was more than doubtful whether in the Greek Pantheon, as little as in that of Babylonia and Assyria, there was such a figure as a "bearded lady." The problem was distinct from that of "hermaphroditism," which is a comparatively late phenomenon in Greek religion, the earliest reference to it being in Theophrastus; nor does it follow from the fact that the goddess in question, both among the Semites and Aryans, was occasionally viewed as having the traits of a male deity, that she would be regarded anywhere at one and the same time as both male and female.

Early Greek Theories of Sound and Consonance: WM. ROMAINE NEWBOLD, Philadelphia.

Historical Aspect of German Mysticism of the Fourteenth Century: KUNO FRANCKE, Cambridge.

A characteristic feature of all Romantic literature is the tendency to oscillate between the extremes of symbolism and naturalism. The dwelling together of these two extremes in particularly intense and particularly refined individuals is nothing accidental. It is founded on the inner affinity between symbolism and naturalism, on their both springing from the common root of an unusually high-strung subjectivity. All truly artistic grasp of life comes from within. The symbolist finds the essence of things in his own inner self. In the throng of shapes and images that arise before him from within he sees the true reality. The tangible and visible he replaces by a world of his own creation, a world of higher, finer, more spiritual values. But the naturalistic artist also is far removed from being a mere imitator of outward reality. He transports himself into the inner life of things, he feels that the whole variety of the outer world streams forth from one mighty source. He feels akin to this mighty power, he feels the impulse to create a living world. His art, therefore, although seemingly objective, is, like that of the symbolist, the product of his own high-pitched subjectivity.

In the few greatest artists of all ages, in a Dante, Shakespeare, Goethe, these two diverging but kindred tendencies, the symbolistic and the naturalistic, are melted together into an indissoluble unity. In less harmonious, more erratic personalities, such as Amadeus Hoffmann, Poe, Ibsen, Hauptmann and other Romanticists, there is, instead of this unity of contrasting elements, a constant clash between them, a continuous oscillation between extravagant symbolism on the one hand, and inexorable naturalism on the other.

A striking illustration of this peculiarity of Romantic literature is to be found in the writing of the German mystics of the fourteenth century.

To an analysis of the symbolistic and naturalistic elements of German mystic literature of the fourteenth century the bulk of the paper was devoted.

The New Shakespeare Discoveries: Felix E. Schelling, Philadelphia.

The newly discovered references to Shakespeare include amongst other things an anecdote concerning his father, a reference to Shakespeare in the capacity of a tax-payer in the parish of St. Helen's Bishops Gate, some other information concerning the coat of arms finally granted to Shakespeare, a reference to Shakespeare as the designer of an impressa for the Earl of Rutland in 1613, and several of the discoveries by Professor C. W. Wallace, recently made in the Public Record Office in London. The chief amongst these is the final settlement of the question of the value and proportion of the interest of Shakespeare in both the Blackfriar's and the Globe theaters and a definite proof of his place of abode during the period of some years from 1598 onward.

A German Monk of the Eleventh Century: A. C. Howland, Philadelphia.

A study of the life and writings of Othloh of St. Emmeram to illustrate the reform tendencies in the religious life of south Germany in the eleventh century. The writings of Othloh are of a peculiarly intimate character and contain more autobiographical material than is to be found in any other writings of the period. Besides the information they give us of the writer's own feelings and ideals they exhibit the two chief characteristics of German religious tendencies in this time—the fostering of an active intellectual life and the inculcation of practical morality. The paper describes the early education of Othloh, his ambition to acquire culture, which led him at one time to contemplate studying in the Moorish schools of Spain, his sudden conversion to the monastic life by what he considered a miracle and his struggles to reconcile the ideals of this new life with his old devotion to poetry and pagan learning. Examples are also given of his moral teachings and his interest in the every-day life of the plain people about him.

New Fields of German-American Research: M. D. Learned, Philadelphia.

Rich fields for investigation may be found in the German archives for researches on the causes of German emigration to the United States. Another promising field is the question of the influence of American ideas on modern German culture.

The Real Meaning of the Controversy concerning Pragmatism: Albert Schinz, Bryn Mawr.

While truth remains always the same, each aspect of truth which we wish to emphasize depends upon accidental circumstances. This is the case of pragmatism, which gives the useful as the criterion of truth. There are two sorts of useful, the scientifically useful and the socially or morally useful. There are conflicts between the two. In such cases of conflict, pragmatists try to substitute the second for the first, *e. g.*, they advocate freedom of the will, or religion on the ground of their moral usefulness. The conclusion is that pragmatism is not really a philosophy of truth, but a philosophy of the expedient, socially speaking; and although pragmatists refuse to acknowledge openly what is clearly contained in their premises, it implies stopping science wherever science conflicts with morality. The author realizes the importance of the social problem involved, but would propose another solution. Instead of stopping science, let us be very cautious in spreading abroad the results of science; let us do away with such institutions as university extension and popular science in magazines. Such pseudo-philosophies like pragmatism ought to be rendered useless by a better economy of scientific truth.

Physical Notes on Meteor Crater, Arizona: William F. Magie, Princeton.

Meteor Crater is a vast crater situated in Coconino County, Arizona, formed by the impact of an iron meteorite, or group of meteorites. Scattered specimens of these meteorites (the Canyon Diabolo siderites and the shale ball siderites) are found around the crater, but the main mass has not yet been found. It probably is buried 1,000 feet below the surface.

1. The Canyon Diabolo iron shows a magnetic permeability not very different from that of cast iron. The shale ball iron seems to be generally similar to it in its magnetic properties. Several observations indicate an intrinsic magnetization, peculiarly arranged, in the shale ball iron. The sheets of iron oxide, formed from the shale ball iron, are often intrinsically magnetic, but have very low permeability.

The magnetic field of the crater shows no local peculiarities such as would be expected from the presence of a large continuous mass of iron. The

inference is that the mass is fragmentary, perhaps intrinsically magnetized, and also perhaps largely oxidized.

2. The distribution of the ejected material and the inclinations of the exposed strata around the crater wall show a remarkable symmetry with respect to a nearly north-and-south axis. This symmetry, even in details, appears in holes made by bullets in a suitable mass of compacted powder. The inference is that the crater was formed by a projectile.

3. The mass ejected is estimated at 330 million tons. The energy used to lift it out of the hole is a negligible fraction of the energy expended. Most of the energy expended was used in crushing the rock. An estimate based on the assumption that the powdered sandstone was heated to 2,500° C. would indicate an expenditure of 92.5×10^{12} ft. tons of energy. Taking everything into account, it seems reasonable to estimate in all an expenditure of 60×10^{12} ft. tons of energy.

Taking this for the energy expended, and estimating the probable velocity of the meteor as lying between 3 and 48 miles a second, the mass of the meteoric group would lie between 15 million and 60 thousand tons.

The size and shape of the crater lead one to estimate a mass larger than this lowest limit; and the final estimate is that the mass is 400 thousand tons and that its velocity was from 18 to 20 miles a second.

The Conversion of the Energy of Carbon into Electrical Energy by Solution in Iron: PAUL R. HEYL, Philadelphia.

It is found that carbon dissolves in molten iron with a liberation of energy, which, by providing a suitable negative element, may be obtained as an electric current. The electromotive force thus developed has not yet been definitely determined, but is probably not more than one or two hundredths of a volt. There is no possibility of compounding this electromotive force with the accompanying thermal effect, as the two are opposite in direction.

The One-fluid Theory of Electricity: FRANCIS E. NIPHER, St. Louis.

The author has shown in a former paper that what have been taken for discharges from the positive terminal of an electrical machine are really optical illusions. The positive discharge is really an inflow of the electrical discharge which flows outward from the negative terminal. This is in harmony with the one-fluid theory of Franklin. With this paper he presents photographic plates showing the discharge from its first stages until the disruptive spark appears. These plates fully confirm the former conclusion that there is no positive electrical discharge. The discharge comes from the negative terminal and goes to the positive.

The illusion which has led to the idea of a positive discharge is compared to one which might prevail if Niagara Falls should suddenly recede from Lake Ontario to Lake Erie. It might deceive us into the idea that there had been a positive discharge into Lake Erie.

The Past and Present Status of the Ether: A. G. WEBSTER, Worcester.

The history of the conception of the luminferous ether was covered from the time of Newton and Huygens to the present. For the last hundred years the belief in the ether as necessary to transmit light has been universal. Lord Kelvin devoted most of his life to establishing its properties. The various mechanical theories were succeeded by Maxwell's successful electromagnetic theory, confirmed twenty years later by the electric wave experiments of Hertz. To explain astronomical aberration and the phenomena due to the earth's motion Maxwell's theory was severely strained, and was perfected by Lorentz. The classic experiment of Michelson on the apparent fixity of the ether to the earth in its motion, was explained by Lorentz, though by the violent assumption that motion changes the dimensions of bodies, and that the local time of a moving observer is different from that of an observer at rest. From this comes Einstein's principle of relativity, which profoundly modifies our ideas of space and time, and leads many radicals to abandon the ether. The "ether crisis" is the leading question in physics to-day.

The Ether Drift: AUGUSTUS TROWBRIDGE, Princeton.

Professor Trowbridge spoke very briefly of the general question of relative motion of matter and the ether, and pointed out that in spite of the experimental work of various investigators we are still in doubt as to whether the earth in its motion through ether-filled space entrains the ether in its motion or not. Next he explained in what respect the experimental method adopted by Professor Mendenhall and himself differed from that of former investigators so as to be free from the objections which have rendered the previous work inconclusive. Lastly a report of progress of

the work which is not yet completed and for the speedy completion of which the Rumford Fund has made an appropriation.

The Effects of Temperature on Fluorescence and Phosphorescence: E. L. Nichols, Ithaca.

A summary of observations on fluorescence and phosphorescence from the temperature of liquid air to ordinary temperatures, showing that the theory of Lenard is inadequate to correlate all the facts.

Infra-red and Ultra-violet Landscapes: Robert Williams Wood, Baltimore.

Photographs taken with infra-red and ultra-violet light, using appropriate absorption screens, show greatly altered contrasts. Thus some substances which are white when viewed by ordinary light appear black when photographed with ultra-violet light. By such photographs it may be possible to obtain additional details concerning the surface markings of the moon and planets.

New Optical Properties of Mercury Vapor: Robert Williams Wood, Baltimore.

Newton's Rings as Zone-plates: Robert Williams Wood, Baltimore.

A zone plate may be automatically produced by photographing Newton's rings in monochromatic light. This may be copied by ruling circles with a diamond on a glass plate mounted on a turn table, the photograph being used as a guide to determine the radii of the rays. Copies of this may then be made in celluloid.

New Surgery of the Viscera of the Chest: Alexis Carrel, New York.

The Cause of Epidemic Infantile Paralysis: Simon Flexner, New York.

A report on the experimental study of poliomyelitis in monkeys which has yielded a large number of important facts relating to the spontaneous disease in man. The nature of the virus has been discovered, many of its properties have been ascertained, some of its immunity effects have been established, the clinical and pathological peculiarities of the disease have been elucidated, and a basis has been secured on which to develop measures of prevention.

Description of the Brain of an Eminent Chemist and Geologist (a member of this Society) together with a Note concerning the Size of the Callosum in Eminent Men: Edward Anthony Spitzka, Philadelphia.

A description of the brain of Persifor Frazer, author of many books, reports and papers on geology, chemistry, mathematical problems and handwriting.

The brain was normal, in good condition, and weighed 1,580 grams, being about 250 grams over that of average persons of his age. The ratio of weight of cerebellum, to that of the cerebrum, is as 1:8.07; while among ordinary men it averages 1:7.5.

Among the pronounced anatomic features which place this brain in the superior class, aside from the weight and fissural complexity, are: (1) superior degree of differentiation of the motor centers for the utterance of speech and for word-arrangement, (2) great redundancy of the right subparietal region encroaching upon and shortening the sylvian fissure, (3) a large corpus callosum, or commissural bundle of fibers joining the two hemispheres of the cerebrum together, affording a superior degree of coordination between them. In Dr. Frazer's brain it measures, in cross-section area, 10.26 sq. cm. The average size of the callosum in ordinary persons is somewat less than 6 sq. cm. Some years ago the author first showed that many eminent men, though not all, have a larger callosum, out of proportion even, to the factor of brain-weight alone. The callosum is most fully developed in the human species concomitantly with the greater development of cerebral parts; it may be looked upon as an index of the elaboration of at least one division of the association systems—*i. e.*, those concerned with bilateral coordinations.

The redundancy of the right posterior association area in Dr. Frazer's brain may be interpreted, in the light of previous investigations on other brains, as corresponding to a superior ability to register and compare the impressions in the visual, auditory and tactile spheres (the concrete-concept sphere).

A Brain of about One Half the Average Weight from an Intelligent White Man: Burt G. Wilder, Ithaca. (Illustrated by specimens, photographs and diagrams.) (Read by title.)

The Poisonous Group in the Protein Molecule: Victor C. Vaughan, Ann Arbor. (Read by title.)

Characteristics of Existing Continental Glaciers: William H. Hobbs, Los Angeles, Cal. (Read by title.)

Dermal Bones of Paramylodon from the Asphaltum Deposits of Rancho la Brea, near Los Angeles, Cal.: William J. Sinclair, Princeton.

The paper describes the mode of occurrence,

shape and microscopic structure of the skin bones of an edentate animal from the Los Angeles asphaltum beds. These bones, which are small pebble-like elements in the skin, resemble closely similar bones occurring in a piece of skin found in a cave at Last Hope Inlet, Patagonia. They are also known to occur in *Mylodon*, a genus of ground sloths formerly living in North and South America. As the structure of the skin bones in *Mylodon* is quite different from what it is in *Grypotherium*, the form from the Last Hope Inlet locality, it was a matter of interest to find out to which of these genera the specimens from the asphalt showed the closer resemblance. Thin sections of the bones were cut and these prove that *Paramylodon* from the asphaltum beds is almost identical, in the structure of the skin bones, with *Grypotherium*, a contemporary of early man in Patagonia.

The Restored Skeleton of Leptauchenia decora: WILLIAM J. SINCLAIR, Princeton.

A restoration of the skeleton of this small extinct hoofed animal from South Dakota has been prepared from specimens in the collection of Princeton University. Hitherto only the skull has been figured. The restoration shows the animal to have been about twenty-one inches long from tip of nose to root of tail and about ten inches high at the shoulder.

Correlation of the Pleistocene of the New and Old Worlds: HENRY FAIRFIELD OSBORN, New York. (Read by title.)

The Primates of the Old and the New Worlds, together with Man: GIUSEPPE SERGI, Rome, Italy. (Read by title.)

A Note on Antarctic Geology: WILLIAM MORRIS DAVIS, Cambridge.

The lively interest now aroused in Antarctic exploration suggests that the special attention of geologists should be directed to a problem of great interest that may possibly be solved by special studies in far southern latitudes. It is well known that fossil plants have been found in various formations in the Arctic and Antarctic regions, indicating the former prevalence there of a much milder climate than that of to-day. Our prepossession naturally favors the present polar climate as having been the ordinary or normal polar climate of all geological time; but inasmuch as milder climates have sometimes occurred, it is eminently possible that they, and not the present rigorous climate, may have been the usual polar climate through the geological ages. Hence a peculiar interest attaches to studies of the minute structures of stratified formations, particularly of such as are of continental origin; for from such studies it may well be possible to determine climatic conditions even in the absence of fossils. It is fitting that attention should be directed to this problem by its discussion before a society that, more than any other in this country, has promoted renewed interest in Antarctic exploration.

The Italian Riviera—A Study in Geographical Description: WILLIAM MORRIS DAVIS, Cambridge.

After a geographer has seen a district it is his responsibility to describe it in such a manner that other geographers who have not seen it may get as clear a conception of it as possible. For this purpose experiment is here made on the picturesque Riviera Levante, between Genoa and Spezia, following the method which may be called the method of "structure, process and stage"; because the land forms observed are treated first in terms of the rock structures of which they are composed; second, in terms of the processes of sculpture that have worked on their surface; third, in terms of the stage of development reached by these processes in their task of the complete destruction of the lands. Briefly stated, the Riviera Levante is a district of deformed strata, for the most part sandstones and limestones of similar resistance, which in an earlier cycle of normal erosion was reduced to small relief; the lowland thus produced was then tilted to the southwest, and in this attitude it was maturely dissected by normal erosive agencies and maturely retrograded by the sea, with the result of having all its spurs cut off in great terminal facets along a simple shore line. This stage of development having been reached, the district was in recent time very gently tilted on an axis through its middle at right angles to the general coast line; and thus slightly elevated to the northwest and depressed to the southeast; as a consequence, an abraded marine platform was revealed in increasing height and breadth to the northwest; while the valleys and sea-cliff facets were submerged to increasing depth towards the southeast. Since this change took place, the streams have cut down mature valleys across the raised platform, and the sea has cut away its outer margin; while on the other side of the axis of tilting, the drowned valleys have been filled with delta deposits, and the cliff-facets have been somewhat steepened at

the new water line. The location of villages and the lines of transportation are shown to be closely related to the forms thus described.

Some Recent Results in Connection with the Absorption Spectra of Solutions: HARRY C. JONES, Baltimore.

The absorption spectra of dissolved substances are not simply a function of the nature of the substances, but also of the nature of the solvents. Thus in the case of solutions of uranyl chloride we have one spectrum in water, another in alcohol, still another in acetone and a spectrum in glycerol which is very different from any of the above. The only way in which we can account for these results is in terms of the solvate theory. The different solvents combine with the dissolved substance and form solvates having very different compositions. These affect the resonance of the vibrators that are the cause of light absorption, differently; and, consequently, the absorption in the different solvents is different.

The second point upon which stress is laid has to do with the action of one acid on the salt of another acid. In terms of prevailing chemical theories, when a salt of one acid is treated with a small amount of another acid, a part of the salt is transformed into the salt of the second acid. With the addition of more and more of the free acid, more and more of the initial salt would pass over into the salt of the second acid. In such solutions we should expect to have the bands of both salts occurring simultaneously, with varying intensity, depending upon the amounts of the two salts present. The fact is that when a salt is treated with a free acid, we have neither the bands corresponding to the initial nor the final salt present, but bands occupying positions intermediate between those of the two salts; and these bands can be made to occupy any intermediate position by suitably varying the amount of the free acid relative to the salt. This shows that between the initial salt, and the one finally formed, there is a series of intermediate compounds or systems, corresponding to the various positions of the bands.

The number of reactions showing the above relations is not small, and this raises the question whether chemical reactions in general are not much more complex than is usually represented by our chemical equations, which deal only with the initial and final stages.

The Propagation of Explosions in Mixtures of Petroleum Vapor with Air in Tubes: CHARLES E. MUNROE, Washington, D. C.

What Constitutes a Species in Agave: WILLIAM E. TRELEASE, St. Louis.

An analysis of the difficulties met with in obtaining flowering and fruiting material in the slow-maturing agaves; in finding spontaneous plants identifiable with many of the garden forms described as species; and in applying vegetative characters consistently and dependably. The conclusion is reached that though differing much in aspect, species of this genus are reasonably constant in their spine and prickle characters—illustrations being derived from the century plants, henequens, zapupes, mezcots and pulque magueys.

Suppression and Extension of Spore-formation in Piper betel: DUNCAN S. JOHNSON, Baltimore.

The interesting feature of the structure of the flower in this plant is the presence of male flowers, female flowers and flowers bearing the organs of both sexes, on three separate kinds of spikes. But flowers of each sex often bear some rudiments of organs of the other sex. This shows that while some flowers are apparently of one sex only, they really possess, in some degree, the power to develop the organs of the opposite sex. In other words, the cells from which the flowers arise are capable of forming the organs of both sexes, and the fact that one sex only is formed is probably due to some influence, internal or external, affecting the cells at the time that the flowers are being initiated.

Experimental work on certain plants has shown that a change in the light or soil supplied to apparently unisexual individuals may cause the organs of the other sex also to appear. This seems clear evidence that both sexes may really be present in all apparently unisexual plants, but that sometimes one, sometimes the other of these is suppressed or fails to become evident. The only plants of which this seemingly can not be true are those well-known unisexual plants like the sago palm, cotton-woods and willows, in which each individual bears only male flowers or only female flowers year after year, throughout the life of the plant. Another case is that of one of the mosses, in which it has been shown by Noll that the sex remained constant for thirty generations when male or female plants are propagated by budding.

A Method of Using the Microscope: N. A. COBB, Washington, D. C.

The Use of the Hydrometer in Phytogeographic Work: JOHN W. HARSHBERGER, Philadelphia.

The distribution of plants in salt marshes and along salt-water estuaries is determined by the percentage of salt in the water and in the soil. This can be estimated indirectly by a hydrometer reading directly the specific gravity of liquids heavier than distilled water, the readings being afterwards reduced to percentages of salinity. This specific gravity can be determined for each salt marsh and saline species of plants by collecting the water at the roots of the plants and estimating its salinity by hydrometer with a thermometer attachment. By this means the transition from salt-water to fresh-water vegetation can be studied.

Solar Activity and Terrestrial Magnetic Disturbances: L. A. Bauer, Washington.

A recent examination of the times of beginning of magnetic disturbances, as recorded at observatories over the entire globe, showed that, without doubt, magnetic storms do not begin at absolutely the same instant of time, as heretofore believed. Instead, they progress around the earth, the times generally increasing as we go around the earth eastwardly; for the quick and abrupt disturbances, which are usually comparatively minute in their effect on the compass needle, the complete passage around the earth requires from three to four minutes. For the bigger effects or for the greater magnetic storms, the rate of progression is slower, so that it would take them a half hour or more to get around the earth completely. There is thus introduced a new point of view in the investigation of the origin of magnetic storms.

In addition to negatively charged electrified particles coming from the sun to which recent theories sought to attribute our magnetic storms, but which the speaker found would produce effects not in harmony with those actually observed, we also receive radiations such as the Röntgen rays, for example, which are not deflected by the earth's magnetic field as they do not carry electric charges. Their chief effect will be to ionize the gases of which the atmosphere is composed, *i. e.*, make the air a better conductor of electricity. Ultra-violet light has the same effect. It is known that a small part of the magnetic forces acting on a compass needle is due not to the magnetism or electric currents below the earth's surface, but to electric currents already existing in the atmosphere and which the speaker showed were brought about by the atmosphere cutting across the earth's lines of magnetic force in its general circulation around the globe. If the regions of these upper electric currents are at any time made more conducting by some cause, electricity will be immediately set in motion, which in turn affects our compass needles.

This new theory, called "the ionic theory of magnetic disturbances," satisfactorily explains the principal features of magnetic storms. As the currents get lower down in the atmosphere their velocity is checked, so that instead of taking but three to four minutes to circulate around the earth, as do the higher currents, it may take them a half hour and more; however, their actual effect on the magnetic needle would be greater because of their coming nearer to the earth. The theory also opens up the possibility of accounting for some of the other changes and variations experienced by the earth's magnetism, and likewise has a bearing on the peculiar formation of the magnetic fields in sunspots discovered by Professor Hale.

Magnetic Results of the First Cruise of the "Carnegie": L. A. Bauer, Washington.

The non-magnetic vessel *Carnegie* completed on February 17 last the first cruise, covering in all since September 1, 1909, 8,000 miles. Special tests made at Gardiners Bay, Long Island, and at Falmouth, England, proved conclusively that there are no corrections to the magnetic instruments of the kind encountered on vessels in which more or less iron occurs in the construction. Thus in a single voyage errors could be disclosed in the compass charts used by mariners on their transatlantic voyages of importance not alone from a scientific standpoint, but from that of practical and safe navigation as well.

The errors found by the *Carnegie* in the declination at various points along the track followed by the vessel from Long Island Sound to Falmouth, England, amounted on the average to about 1 degree—an error which persisted in the same direction for long distances.

After leaving Falmouth, the *Carnegie* headed for Funchal, Madeira. Thence she sailed to Bermuda, and finally arrived at Brooklyn, February 17. In spite of the unusually adverse conditions frequently met with during this first cruise, more or less extensive magnetic observations were secured almost daily.

The errors of the compass charts were found in general even more pronounced for the southerly half of the cruise, viz., Madeira to Bermuda, than for the northerly half, and were again shown to be systematic in their nature. Some of the charts were in error two to three degrees.

For the entire cruise important corrections were also disclosed for the charts which give the lines of equal magnetic dip and of equal magnetic force.

The *Carnegie* is now being fitted out for a circumnavigation cruise of about three years. Meantime, the magnetic surveys of unexplored countries are pushed, so that it is confidently expected that by the year 1915 the general magnetic survey of the greater part of the globe will have been completed in sufficient detail to permit the construction and issuing of a new set of magnetic charts.

Spectra of Recent Comets: Edwin B. Frost, Williams Bay, Wis.

On the Distances of Red Stars: Henry Norris Russell, Princeton.

Comparison of the parallaxes of stars, derived by the writer from photographs taken at the Cambridge Observatory (England) by Mr. A. R. Hinks and himself, and their spectra, determined at Harvard under the direction of Professor Pickering, shows a marked correlation between spectral type and parallax.

The proportion of orange and red stars (types K and M) among those of large proper motion, and especially among those shown by direct measurement to be our near neighbors, is very much greater than among the general run of stars of the same apparent brightness. Conversely, stars of the same apparent brightness and proper motion average nearer to u the redder they are.

It follows that these stars are intrinsically fainter the redder they are, the reddest ones averaging only one fiftieth as bright as the sun. On the other hand, many bright red stars (such as Arcturus) are at great distances, and are actually at least one hundred times as bright as the sun.

All this can be explained on the hypothesis (now well established on other grounds) that the reddest stars are the lowest in temperature. With the latest determinations of temperature and surface brightness, it appears that the fainter red stars are somewhat smaller, and presumably denser, than the sun, while the brighter ones are very much larger than the sun, and presumably of very small density. The latter class probably represent an early stage of evolution, and the former the latest stage that can be observed.

A Standard System of Photographic Stellar Magnitudes: Edward C. Pickering, Cambridge.

Since 1879, about two million photometric observations of one hundred thousand stars have been made at the Harvard College Observatory. The results, published in volumes 50, 54 and 70 of the *Harvard Annals*, furnish a standard scale for determining the brightness of the stars in all parts of the sky, according to a uniform system.

The general introduction of photography in nearly all departments of astronomy has created an urgent need for a similar scale to give the photographic magnitudes of the stars. The two scales will differ, since red or yellow stars will always photograph faint. The scale proposed will be the same for white stars as the visual scale. Three methods are adopted in this work for determining the photographic brightness. First, correcting the visual magnitude by the class of spectrum. Secondly, by measuring with great care the photographic brightness of a sequence of stars near the north pole, and superposing this photographically on the stars to be measured. Thirdly, by attaching to the object glass of the telescope a small prism, a second image of each star, five magnitudes fainter than the principal image, is formed.

All three of these methods are in use on a large scale at the Harvard Observatory, and it is hoped that, as the result of many thousand measures, a satisfactory solution of the problem will be found.

The Existence of Planets about the Fixed Stars: T. J. J. See, Mare Island, Cal. (Read by title.)

Results of Recent Researches in Cosmical Evolution: T. J. J. See, Mare Island, Cal. (Read by title.)

Some Interesting Double Stars: Eric Doolittle, Philadelphia.

The many thousand double stars in the sky may be divided into two classes. There are some in which the two stars are not really near each other, but which merely happen to lie in the same direction as viewed from the earth, and there are others which form true systems composed of two suns revolving about their common center of gravity. In the latter case, measures show that one sun revolves about the other in an elliptic orbit. It often happens that a very few measures of such a system secured at certain critical times throw unusual light on the nature of the motion and the size of the orbit. This is especially the case when the companion star apparently ceases its motion in one direction and begins to move backward, and also when the companion is passing nearest the principal star. Several diagrams

were shown describing measures of this kind which had recently been secured. An account was also given of the discovery of a very close double star during its occultation by the moon.

Radioaction in the Heavenly Bodies: MONROE B. SNYDER, Philadelphia.

Radioaction the Cause of Hale's Anomalous Solar Spectrum: MONROE B. SNYDER, Philadelphia.

Certain Singularities in the Problem of Several Bodies: EDGAR ODELL LOVETT, Houston, Texas. (Read by title.)

Groups Generated by two Operators, each of which Transforms the Square of the Other into a Power of Itself: GEORGE A. MILLER, Illinois. (Read by title.)

The Origin of our Alphabet and the Race of the Phenicians: PAUL HAUPT, Baltimore.

The Phenicians were not of Semitic stock, but colonists probably from Crete or Cyprus. The origin of the alphabet can hardly be ascribed to them as the derivation of the letters points to their having originated among a more agricultural community.

HORACE CLARK RICHARDS

THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

SOCIAL AND ECONOMIC SCIENCE[1]

FOUR sessions of the Section of Social and Economic Science were held at the Boston meeting, including the first, at which the vice-presidential address was the feature; the second, at which social questions, such as divorce, immigration and public baths, were discussed and papers read; an economic and statistical session with papers on costs of public works, methods of assessments in taxation and general economic progress; and a final session at which were considered the tariff in its more scientific phases, timber growing, economic clubs, racial studies and the mathematical measurements of the economic earning power of the individual man. Out of fourteen assignments on the program, twelve of the authors were present and read their papers in person.

The vice-presidential address, by Byron W. Holt, on "The Gold Question" was published in the January number of *Moody's Magazine*, and J. F. Crowell's paper, on "Some Consequences of Advancing Prices," in the February issue of the same periodical.

[1] Boston meeting, December, 1909.

Among the papers of special scientific merit, embodying the results of research, were those of Harrison P. Eddy, C.E., on the "Desirability of the Contract System of Constructing Public Works," in comparison with other methods employed in municipal administration; and of A. C. Pleydell, secretary of the New York Tax Reform Association, on "The Need for More Scientific Methods of Assessment." The latter paper dealt with the conditions of corporate assessment under liability to local government units. Professor Lazenby's paper on "Timber Trees of Ohio" gave an instructive account of the growth of timber to meet specific commercial needs.

Under "Phases of Economic Progress in the United States," Col. Albert Clarke summarized the achievements in the following fields: aeronautics, automobiles, agriculture, hydro-electrics, canal construction and irrigation during the past ten years.

Fred C. Croxton, of Washington, outlined some of the results of the work of the United States Immigration Commission, with special regard to the adjustment of the immigrant to the various industries and occupations.

William H. Hale, of Brooklyn, described the work of the public baths administration in that city as evincing a tendency to look upon it as a public necessity, and reported that over 2,274,000 people had availed themselves in the eleven months ending November 30, 1909.

J. W. Beatson, of the National Economic League, Boston, reported on the extension of economic clubs in New England and eastern cities, with memberships ranging from 200 to 1,500 each, where nearly 500 subjects had been discussed.

Seymour C. Lewis, of New Haven, Conn., described the purpose and limitations of the tariff board as the first step in the direction of a scientific mastery of the tariff problem.

Samuel W. Dyke, Auburndale, Mass., summarized the present status of the divorce question in the United States, stating that the present ratio of divorce to marriage was about one to twelve; that the average length of married life before divorce for the past twenty years was 9.9 years, and that separation in 27 per cent. of the known cases occurs within less than two years of married life.

Dr. E. E. Holt, of Portland, Me., presented a paper on the mathematical formula of the normal earning ability of the individual, defining the

earning ability as composed of functional, technical and competing ability, and giving a specific value to each one of the elements of which the bodily organization was composed.

Papers read by title or by abstract were one by E. L. Blackshear, of Prairie View, Texas, on the "American Negro," and another by Alberto Pectorino on "South European Immigration."

JOHN FRANKLIN CROWELL,
Acting Secretary

NEW YORK

SOCIETIES AND ACADEMIES

THE BOTANICAL SOCIETY OF WASHINGTON

THE sixty-second regular meeting of the society was held at the Ebbitt House, April 23, 1910, at eight o'clock P.M.; President Wm. A. Taylor presided. Robert A. Young and Harry B. Shaw were elected to membership. The following papers were read:

Characteristic Floral Regions of Utah: IVAR TIDESTROM.

With the exception of the region about St. George and possibly along the Colorado River, Utah may be divided into the following floral regions: the river or swamp area, *Scirpetum;* the desert or mesa, *Sarcobatetum;* the foothills, including the lower cañon, *Quercetum;* the aspen region, *Populnetum;* the fir region, *Abietum;* there is no strictly alpine region.

The first mentioned region, *Scirpetum*, is characterized by *Scirpus occidentalis*, which forms dense colonies in places and can be distinguished at some distance by its dark green aspect. There are numerous other aquatic or swamp plants, but the rush is characteristic of the area.

The second region has a number of characteristic plants, among which abound species of *Chrysothamnus* and *Atriplex*, which cover large areas in places. The greasewood, however, is the most characteristic plant of that region, particularly in the saline areas.

In the foothill region are found the piñon and the Utah cedar, and in the cañons, *Quercus utahensis*. The latter is a shrub found at an altitude approximately between 1,500 m. and 2,000 m., and characterizes the *Quercetum*. In this region there occur a number of shrubs, such as *Peraphyllum*, *Cercocarpus* and others.

On the lower mountain sides *Populus tremuloides* forms a distinct belt. This region is very distinguishable from a distance, especially in the autumn when the leaves of the aspen have turned to a golden yellow, and it is bordered above and below by the dark cedars or piñons, with the still darker firs above. The aspens ascend the mountain sides to about 2,850 m. and higher under favorable circumstances. Mingled with the aspens and ascending above to 3,000 m. or higher, we find the Englemann spruce and the alpine fir. Both of these trees reach a considerable height in protected places but on the high ridges and summits they are sometimes reduced to mere shrubs.

Arbens lasiocarpa is the characteristic tree of the *Abietum.*

Apparent Mutations in Soil Bacteria: KARL KELLERMAN.

Agricultural Conditions in the Panama Canal Zone: WM. A. TAYLOR.

A general account of the agriculture of the Canal Zone as seen by the writer in a recent visit to that region. The primitive methods in vogue were illustrated by numerous photographs.

W. W. STOCKBERGER,
Corresponding Secretary

THE AMERICAN CHEMICAL SOCIETY NEW YORK SECTION

THE eighth regular meeting of the session of 1909–10 was held at the Chemists' Club on Friday, May 6.

Professor Julius Stieglitz, of the University of Chicago, gave a talk on the "Electrolytic Theory of Oxidation and Reduction." This address was a logical and well-rounded application of the electrolytic theory to all classes of oxidation—by salts, by oxygen, by air, by nitric acid, by permanganate, etc., including oxidation of organic substances like sugar and formaldehyde. The main purpose was to show that this theory can be used in elementary chemistry and as a working basis in any chemist's every-day ideas of oxidation, without any difficulty whatever. The address was illustrated by numerous lecture table experiments.

Preceding Professor Stieglitz's address, the following papers were read:

"On the Action of Crushed Quartz upon Nitrate Solutions," Harrison E. Patten.

"Stilbazoles in the Quinazoline Group," G. D. Beal and M. T. Bogert.

"Estimation of Iodine in Organic Compounds and other Halogens," A. F. Seeker and W. E. Mathewson.

C. M. JOYCE,
Secretary

SCIENCE

Friday, June 10, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of Science, Garrison-on-Hudson, N. Y.

PRACTICAL SCIENCE[1]

Men who spend their lives in universities are apt to develop certain unfortunate peculiarities. These peculiarities may not make them less happy, or less useful to their professional students, but they diminish the appreciation of the community at large. In the life of an instructor or investigator of university rank there is a peculiar kind of isolation that is bound to react.

It is partly the isolation of a subject, which is more or less segregated from general human interests, at least in the aspects of it the university man is cultivating. As a consequence, he feels that his world is quite apart from that one in which the majority of men are living. He is conscious of an interest distinct from their interests, which seem therefore relatively trivial. This sense of intellectual aloofness does not result in a feeling of loneliness, but rather in a feeling of superiority, unconscious in many cases, but often naïvely expressed.

It is also the isolation of authority, which comes from mastery of a subject and from association with students who recognize this mastery. To speak with authority in intellectual matters, to give the deciding word, to meet a constant succession of inferiors, is apt to affect any man's brain. Either he becomes dogmatic in expression, or he must hold himself in check with an effort. It is the same reaction that was observed in the case of the clergy, when acknowledged authority in position

[1] Address at the winter convocation, 1910, of the University of Chicago.

resulted in an assumption of authority in belief.

The larger the university, the more intense does this sense of the isolation of superiority and of authority become, for it is stimulated by association with its own kind. There is much honest effort to break down this barrier between the scholars who represent universities and the great host of men who represent the community. These men are not so isolated, but they are just as dogmatic in their own way, and they are immensely influential. Even when the two groups mingle, the scholar is often only a man of incidental interest, who possesses much curious information about many useless things. And the scholar usually enjoys being drawn out and made to display his curiosities, for it has the familiar flavor of the classroom, with its intellectually inferior students.

Of course such contact between scholar and community is not the effective one, for it is merely that of audience and entertainer. Here are two groups of men, both powerfully equipped, who should be mutually stimulating in all that makes for progress. Mutual stimulation can follow only after mutual understanding. It is not for me to explain the community to the scholar, but rather to explain the scholar to the community. Even this subject is far too large, for scholarship has many phases, all the way from artistic appreciation to scientific synthesis. I shall try to explain in outline only the scientific aspect of scholarship, and its significance to the community.

It is evident that the public is somewhat interested in scientific research. The most available index of the present interest is furnished probably by the newspapers and magazines, which try either to respond to the desires of their readers, or to cultivate desires. Even a cursory examination of the material they furnish, which may be said to deal with research, shows that it is scanty in amount, sensational in form and usually wide of the mark. The fact that it is scanty in amount is a cause for congratulation, if it must involve the two other features. The sensational form is a concession to what is conceived to be public taste; and while to a scientific man this form seems to exhibit the worst possible taste, the serious objection is that to secure the form truth is usually sacrificed. Some of the results of this kind of information are as follows:

Men engaged in research are looked upon in general as inoffensive but curious and useless members of the social order. If an investigator touches now and then upon something that the public regards as useful, he is singled out as a glaring exception. If an investigation lends itself to announcement in an exceedingly sensational form, as if it were uncovering deep mysteries, the investigator becomes a "wizard," and his lightest utterance is treated as an oracle. The result is that if the intelligent reading public were asked to recite the distinguished names in science, they would name perhaps one or two real investigators unfortunate enough to be in the public eye, several "wizards," and still more charlatans. The great body of real investigators would be known only to their colleagues, thankful that they were not included in any public hall of fame. And yet the public is not to be blamed, for it is giving its best information; and the fact that it has even such information indicates an interest that would be wiser were it better directed. This better direction is dammed up behind a wall of professional pride, which makes an investigator look askance at any colleague who has broken through it. The intelligent public is certainly interested, but it is just as certainly

not intelligently interested. I wish to analyze the situation briefly.

There is a conventional application of the term science, which I will use for convenience. Thus applied, there has arisen a classification of science into two phases, called pure science and applied science. This distinction is one that not only exists in the public mind, but it is also reinforced by published statements from colleges and universities. An attempt to define these two kinds of science reveals the fact that the distinction is a general impression rather than a clear statement. A general impression is usually sufficient for the public, but it ought not to be sufficient for the universities.

If the impression be analyzed, it seems that pure science is of no material service to mankind; and that applied science has to do with the mechanism of our civilization. The distinction, therefore, is based upon material output. In other words, pure science only knows things, while applied science knows how to do things. This impression, rather than distinction, has been unfortunate in several ways.

The public, as represented by the modern American community, believes in doing things; and therefore to them pure science seems useless, and its devotees appear as ornamental rather than as vital members of human society, to be admired rather than used. The reaction of this sentiment upon opportunities for the cultivation of pure science is obvious.

On the other hand, the universities, as represented by their investigators, believe in knowing things; and therefore to them applied science seems to be a waste of investigative energy, and its devotees appear to be unscientific, very useful, but not to be acknowledged as belonging to the scientific cult.

The reaction of this sentiment sometimes has been to avoid the investigation of problems that have an obvious practical application, and to justify Lowell's definition of a university as "a place where nothing useful is taught."

In this atmosphere of mutual misunderstanding the public and the universities have continued to exist and to make progress, all the time acknowledging their interdependence by mutual service.

In recent years, however, a new spirit is taking possession of the public and it has invaded the universities. In fact, so conspicuous have the universities become in the movement that they seem to be the leaders; certainly they furnish the trained leaders. The new spirit that is beginning to dominate increasingly is the spirit of mutual service. It is called by a variety of names, dependent upon the group that proclaims it; it is narrow or broad in its application, dependent upon the moral and intellectual equipment of its promoters; but it is the same enduring idea.

The university is no longer conceived of as a scholastic cloister, a refuge for the intellectually impractical; but as an organization whose mission is to serve society in the largest possible way. Furthermore, this service is conceived of not merely as the indirect contribution of trained minds, a contribution of inestimable value, as we believe; but also as the direct contribution of assistance in solving the problems that confront community life.

This new animating spirit is so attractive and inspiring, appealing to what seem to be our best impulses, that it threatens to become a real danger not only to universities, but to the whole scheme of education down to the primary school. The reaction is natural, and therefore inevitable; but its demands must be recognized as representing the primary and extreme recoil stage of a new motive. The new motive must not

eliminate all the old motives, but must adjust itself efficiently among them. For example, there is abroad an increasingly insistent demand that in the primary and secondary schools all instruction in pure science shall be discarded and various forms of applied science substituted, the imaginary distinction being that which has been indicated. The same pressure is being felt in the college, not to the extent of substitution, but to the extent of adding impossible courses and weakening existing ones. My present thesis, however, is interested chiefly in the fact that the same pressure has begun to be applied to the research work at universities. This pressure is applied not only by public demand, which voices the supporting constituency of most universities, especially of the middle west; but also by the extensive scientific work of state and federal governments, in which for the most part the immediate practical aspect must dominate. The more recent developments at our state universities are impressive illustrations of this pressure; and as a result, in such universities scientific research, in connection with problems that do not seem to be related at present to the welfare of the community, is living in a depressing atmosphere.

It is time for the public and for the managers of universities to understand the real relation that exists between what they have been pleased to call pure science and applied science. I can not hope to make a statement that will appeal to all concerned, but it may serve some useful purpose.

As an introductory illustration, there may be outlined the usual steps that science has taken in the material service of mankind. An investigator, stimulated only by what has been called "the delirious but divine desire to know," is attracted by a problem. No thought of its usefulness in a material way is in his mind; he wishes simply to make a contribution to knowledge. No one can appreciate the labor, the patience, the intellectual equipment involved in such work unless he has undertaken it himself. The investigator succeeds in solving his problem, and is satisfied. Later, perhaps many years later, some other scientific man discovers that the results of the former may be used to revolutionize some process of manufacture, some method of transportation or communication, some empirical formula of agriculture, some practise in medicine or surgery. The application is made and the world applauds; but the applause is chiefly for the second man, the practical man. Any analysis of the situation, however, shows that to the practical result both men contributed, and in that sense both men, the first no less than the second, were of immense material service. The ratio that exists between scientific men of the first type and those of the second is not known, but there is very great disparity.

Another illustration is needed as a corollary. In this case an investigator, stimulated by the desire to serve the community, is attracted by a problem. He also wishes to make a contribution to knowledge. He succeeds in solving his problem, perhaps makes his own application, and is satisfied. Later, some other scientific man discovers that the results of the former may be used to revolutionize certain fundamental conceptions of science. His statement is made and the scientific world applauds; and this time also the applause is chiefly for the second man, the pure scientist. The analysis of this case shows, however, that to the scientific result both men contributed; and that both men were of large scientific service.

A third illustration is needed to complete the real historical picture of progress

in scientific knowledge and in its material applications. A practical man, not trained as an investigator, faces the problem of obtaining some new and useful result. His only method is to apply empirically certain formulæ that have been developed by science, but with ingenuity and patience he succeeds, although he is not able to analyze his results. And yet, his procedure reveals to a trained investigator a method or certain data that lead to a scientific synthesis of the first order.

With such illustrations taken to represent the actual historical situation, what may be some of the conclusions?

It is evident that responsibility for the material results of science is to be shared by those engaged in pure science, those engaged in applied science and those not trained in science at all. The only distinction is not in the result, therefore, but in the intent. As one of my colleagues has aptly said, the difference between pure science and applied science, in their practical aspects, resolves itself into the difference between murder and manslaughter; it lies in the intention. So long as the world gets the results of science, it is not likely to trouble itself about the intention. In every end result of science that reaches the public, there is an inextricable tangle of contributions. Between the source of energy and the point of application, there may be much machinery, and perhaps none of it can be eliminated from the final estimate of values. And yet, the public is in danger of gazing at the practical electric light and forgetting the impractical power house; and schools are being asked to turn on the electric light and to shut off the power house.

Another conclusion is that all application must have something to apply, and that application alone would presently result in sterility. There must be perennial contributions to knowledge, with or without immediately useful intent, that application may possess a wide and fertile field for cultivation. It is just here that the menace to education is evident. When education in science becomes a series of prescriptions, to be followed without understanding and without perspective, it will train apprentices rather than intelligent thinkers. Of course there is a place for just this kind of training and there are individuals who need it; but the place does not seem to be the schools for general education, and the individuals are evidently not all those who pass through these schools, or even a majority of them.

A third conclusion is that there is nothing inherent in useful problems that would compel their avoidance by an investigator who wishes to contribute to knowledge. While such an investigator should never be handicapped by the utilitarian motive, at the same time he should never be perversely non-utilitarian. I feel free to make this statement, for perhaps no field, within the confines of my own general subject, seems to be more non-utilitarian than the special one I have chosen to cultivate. There is no reason why a university, especially one dominated by research, should not include among its investigations some that are of immediate concern to the public welfare.

A final conclusion may be that all science is one; that pure science is often immensely practical; that applied science is often very pure science; and that between the two there is no dividing line. They are like the end members of a long and intergrading series; very distinct in their isolated and extreme expression, but completely connected. If distinction must be expressed in terms where no sharp distinction exists, what seems to me to be a happy suggestion, made by one of my colleagues,

is the distinction expressed by the terms fundamental and superficial. They are terms of comparison and admit of every intergrade. In general, a university devoted to research should be interested in the fundamental things of science, the larger truths, that increase the general perspective of knowledge and may underlie the possibilities of material progress in many directions. On the other hand, the immediate material needs of the community are to be met by the superficial things of science, the external touch of more fundamental things. The series may move in either direction, but its end members must always hold the same relative positions. The first stimulus may be our need, and a superficial science meets it, but in so doing it may put us on the trail that leads to the fundamentals of science. On the other hand, the fundamentals may be gripped first, and only later find some superficial expression. The series is often attacked first in some intermediate region, and probably most of the research in pure science may be so placed; that is, it is relatively fundamental; but it is also relatively superficial. The real progress of science is always from the superficial toward the fundamental; and the more fundamental are our results, the more extensive may be their superficial expression. In short, my subject, "practical science," is no subject at all, if it implies a special kind of science, for all science is practical.

I can not leave science in the position of working on the chance that some of its results some day may be found to be of material service to mankind. I have been speaking the language of those who measure usefulness in terms of its market price, and even at that low level the results of science easily control the market. Perhaps there are some who think that this is the only level at which the usefulness of science is conspicuous; for it is often thought of as the Pullman car of our civilization, and not the passenger; something that contributes to our convenience and comfort, but something quite apart from our intellectual and moral selves.

To my mind, the largest usefulness of science, its contribution of immeasurable value to human welfare, is on the intellectual level. It has developed and is continuing to develop the scientific attitude of mind, an attitude that has literally revolutionized thinking, so that all subjects and all education have become scientific. No more impressive testimony to this wide and revolutionary influence of the scientific spirit could be given than that contained in the numerous memorial volumes of last year in honor of Charles Darwin, for his contribution was not so much the theory of natural selection as the scientific point of view. Perhaps the volume from his own university illustrates this most compactly. It contains papers written by 29 men, easily among the leaders in their respective fields, and representing the widest possible range of universities, and all united in saying that this embodiment of the scientific spirit revolutionized not only zoology and botany and geology and astronomy, but also the study of language, of history, of sociology, of philosophy and of religion. This means that all subjects worthy of study and worthily studied have become scientific. It also means that this same scientific attitude is available for our social problems, immensely more important and vital than our material problems, for they deal with human welfare. Without attempting to analyze in any adequate way what has been called the scientific attitude of mind, or the scientific spirit, I wish to indicate three of its useful characteristics.

1. *It is a spirit of enquiry.*—In our ex-

perience, we encounter a vast body of established belief in reference to all important subjects, such as society, government, education, religion, etc. It is well if our encounter be only objective, for it is generally true, and a more dangerous fact, that we find *ourselves* cherishing a large body of belief, often called hereditary, but of course the result of early association. Nothing seems more evident than that all this established belief that we encounter belongs to two categories: the priceless result of generations of experience, and heirloom rubbish. Toward this whole body of belief the scientific attitude of mind is one of unprejudiced inquiry. So far as the attitude is prejudiced, it is unscientific. This is not the spirit of iconoclasm, but an examination of the foundations of belief. It is evident that this spirit is diametrically opposed to intolerance, and that it can find no common ground with those who affirm confidently that the present organization of society is as good as it can be; that our republic represents the highest possible expression of man in reference to government; that the past has discovered all that is best in education; that the mission of religion is to conserve the past rather than to grow into the future. This is not the spirit of unrest, of discomfort, but the evidence of a mind whose every avenue is open to the approach of truth from every direction. For fear of being misunderstood, I hasten to say that this beneficial result of scientific training does not come to all those who cultivate it, any more than is the Christ-like character developed in all those who profess Christianity. I regret to say that even some who bear great names in science have been as dogmatic as the most rampant theologian. But the dogmatic scientist and theologian are not to be taken as examples of "the peaceable fruits of righteousness," for the general ameliorating influence of religion and of science are none the less apparent. It is not the speech of the conspicuous few that is leavening the lump of human thought, but the quiet work of thousands of teachers.

2. *It is a spirit which demands that a claimed cause shall be demonstrated.*—It is in the laboratory that one first really appreciates how many factors must be taken into the count in considering any result, and what an element of uncertainty an unknown factor introduces. Even when the factors of some simple result are well in hand, and we can combine them with reasonable certainty that the result will appear, we may be entirely wrong in our conclusion as to what in the combination has produced the result. For example, the forms of certain plants were changed at will, by supplying to their surrounding medium various substances. It was easy to obtain definite results, and it was natural to conclude that the chemical structure of these particular substances produced the result, and our prescription was narrowed to certain substances. Later it was discovered that the results are not due to the chemical nature of the substances, but to a physical condition developed by their presence, a condition which may be developed by other substances or by no substances; and so our prescription was much enlarged.

There is a broad application here. In education, we are in danger of slavery to subjects. Having observed that certain ones may be used to produce certain results, we prescribe them as essential to the process, without taking into account the possibility that other subjects may produce similar results. In religion, we are in danger of formulating some specific line of conduct as essential to the result, and of condemning those who do not ad-

here to it. That there may be many lines of approach to a given result, if that result be a general condition, is a hard lesson for mankind to learn.

If it is so difficult to get at the real factors of a simple result in the laboratory, and still more difficult to interpret the significance of factors when found, in what condition must we be in reference to the immensely more complex problems that confront us in social organization, government, education and religion, especially when it is added that the vast majority of those who have offered answers to these problems have had no conception of the difficulties involved in reaching truth? The proper effect of such knowledge is not despair, but an attentive and receptive mind.

The prevailing belief among the untrained is that any result may be explained by some single factor operating as a cause. They seem to have no conception of the fact that the cause of every result is made up of a combination of interacting factors, often in numbers and combinations that are absolutely bewildering to contemplate. An enthusiast discovers some one thing which he regards and perhaps all right-thinking people regard as an evil in society or in government, and straightway this explains for him the whole of our present unhappy condition. This particular tare must be rooted up, and rooted up immediately, without any thought as to the possible destruction of the plants we must cultivate.

This habit of considering only one factor, when perhaps many are involved, indicates a very primitive and untrained condition of mind. It is fortunate when the leaders of public sentiment have gotten hold of one real factor. They may overdo it, and work damage by insisting upon some special form of action on account of it, but so far as it goes it is the truth. It is more apt to be the case, however, that the factor claimed holds no relation whatsoever to the result. This is where political demagoguery gets in its most unrighteous work, and is the soil in which the noxious weeds of destructive socialism, charlatanism and religious cant flourish.

3. *It keeps one close to the facts.*—There seems to be abroad a notion that one may start with a single well-attested fact, and by some logical machinery construct an elaborate system and reach an authentic conclusion, much as the world has imagined that Cuvier could do if a single bone were furnished him. The result is bad, even though the fact may have an unclouded title. But it happens too often that great superstructures have been reared upon a fact which is claimed rather than demonstrated. Facts are like stepping stones; so long as one can get a reasonably close series of them he can make some progress in a given direction, but when he steps beyond them he flounders. As one travels away from a fact its significance in any conclusion becomes more and more attenuated, until presently the vanishing point is reached, like the rays of light from a candle. A fact is really influential only in its own immediate vicinity; but the whole structure of many a system lies in the region beyond the vanishing point.

Such "vain imaginings" are delightfully seductive to many people, whose life and conduct are even shaped by them. I have been amazed at the large development of this phase of emotional insanity, commonly masquerading under the name of "subtle thinking." Perhaps the name is expressive enough, if it means thinking without any material for thought. And is not this one great danger of our educational schemes, when special stress is laid upon

training? There is danger of setting to work a mental machine without giving it suitable material upon which it may operate, and it reacts upon itself, resulting in a sort of mental chaos. An active mind, turned in upon itself, without any valuable objective material, certainly can never reach any very reliable results. It is the trained scientific spirit which recognizes that it is dangerous to stray away very far from the facts, and that the farther one strays away the more dangerous it becomes, and almost inevitably leads to self-deception.

It is such an attitude of mind that scientific training is contributing to the service of mankind. This does not mean that all scientific men exhibit this attitude to the full, but that it is their ideal. This ideal has realized some tremendous results during the last half century, and there is every evidence that it is accumulating momentum for a much larger expression. Compared with this contribution, the material usefulness of science seems tawdry. In general, the world's standards of usefulness are tawdry, but education ought to correct them rather than maintain them.

The conclusion is that all science is immeasurably useful, from fundamental to superficial, on the material plane and on the intellectual plane; and that in these two regions of human need it is the most valuable practical asset the world possesses.

JOHN M. COULTER

BOTANY IN ITS RELATIONS TO AGRICULTURAL ADVANCEMENT[1]

FEW things are more interesting to one of a philosophic cast of mind, especially if he be something of a botanist or agriculturist, than a growing collection of plant varieties. However sluggish of intellect one may be, such a collection—representing forms developed in the long history of the cultivator's art—is sure to excite one's interest regarding their origin. At first thought it would seem that as practically all of the numerous varieties that exist in cultivated plants have been developed as it were under the eye of the grower, we should have a pretty clear understanding and agreement as to their mode of origin. Yet few subjects have proved more perplexing. The stock answer of the breeder or gardener to one's inquiries is usually embodied in the words *sports* and *hybrids*. Is this answer adequate? The enormous importance of the subject, it would seem, should have incited the most intensive study into the problem. Few plants in their ordinary wild forms will repay cultivation. It is only through their improvement that a permanent agriculture became possible. The very baffling nature of the problems presented, instead of attracting students, seems to have repelled them. Systematic botanists have looked upon cultivated plant varieties as artificial products—useful, no doubt, but utterly subversive to notions of classification obtained from plants in their natural habitats. Therefore, they have been neglected and no plants are so rare in museum collections as our common cultivated ones. Such a thing as a reasonably complete herbarium of cultivated plant varieties nowhere exists. The natural result of this has been that the systematic botany of cultivated plants is in woeful confusion. As a rule, numerous botanical species have been based on purely agricultural varieties, but in some cases the opposite extreme is found and perfectly distinct species are confused as garden varieties. As a natural consequence of this neglect by botanists, the great mass of information we have concerning any cultivated plant is largely

[1] Address of the retiring president before the Botanical Society of Washington, March 5, 1910.

the work of men of little or no botanical training.

With the establishment of the numerous agricultural experiment stations in all parts of the world, the doors were opened wide to scientific men to work for the advancement of agriculture. It is instructive to review the general trend of what took place in the fields of agronomy and horticulture, which, broadly speaking, not only cover the whole subject of crop plants, but soils as well. Generally speaking, there are four potent and more or less controllable factors which affect the yield of crops. These are *tillage, fertilizers, rotations* and *variety of plant*. To these might be added the prevention of loss by diseases or insects. Broadly speaking, three types of scientific men went into agronomic work. First, those who were interested in the study of fertility. For the most part, these men were and are chemists and they have studied their problem largely or wholly from a chemical standpoint. Probably as a result of their chemical training the field plot work of these investigators is by far the most accurate agronomic field work conducted. The theoretical side of the subject of soil fertility has recently been stimulated by vigorous attacks on the long-accepted theory of available plant food—an explanation so luminously simple that a few pages of text sufficed to tell the whole story. It may devoutly be hoped that a renewed activity in the study of fertility may stimulate botanical work on the nutrition side of the problem—which is pretty nearly where Sachs left it forty years ago. The second class of scientific men who were attracted to agronomic work were botanists. In large measure, these men undertook investigations dealing with plant diseases, with the end in view of preventing or curtailing the serious losses resulting from such causes. The results of their work furnish the best contributions that botany has thus far conferred on agriculture in this country. So far as field crops are concerned, there are decided limitations to the use of any direct preventive methods such as spraying. As a natural result, investigators of the diseases of such plants were forced to adopt one of two lines of approach to the solution of the problems involved. They could either seek for immune or resistant varieties or they could make a comprehensive study of the crop and the disease and endeavor by such indirect methods as rotations to curtail the disease loss. In either case the result was that the pristine pathologist often graduated into an agronomist. The third class of men who went into crop investigations were generally termed agriculturists and horticulturists. They constituted by far the most diverse group. In a few cases they were simply good farmers. In some cases they were men of very broad training. For the most part they were men with good general equipment. To these men fell the great bulk of the field work involving principally investigations into tillage, rotations and the testing of crop varieties. It thus fell largely to this third class to investigate the complex problems of plant varieties. Even in the few cases where experiment-station agriculturists and horticulturists had good botanical training, the diverse problems facing them as well as paucity of literature gave little opportunity for far-reaching studies. Generally speaking, one of two plans was pursued. In the one case a series of varieties was grown, and all but a few of the apparently most promising were discarded without further ado. In the other case more or less full information was

published regarding each of the varieties tested. Further investigations have clearly revealed the very superficial nature of most of these varietal studies. In general, the collections consisted of such varieties as could be gathered locally and through seedsmen. In only a few cases have specimens been preserved, so that it is not possible now to verify or determine the varieties grown, though in many cases it is certain from the notes that the variety published on was not true to name. There has thus been placed on record a mass of misinformation regarding many varieties. In my opinion, at least fifty per cent. of the varieties that have been published upon are either untrue to name or unidentifiable. I hope I may not seem to be pessimistic in portraying the present status of much of the published information on crop varieties. It is the natural result of neglect by men of proper training to do accurate work of a purely botanical character. As an indirect result of this failure by botanists to apply their trained skill to the problems of agriculture, especially as concerns knowledge of crop varieties, there has arisen the idea that training in systematic botany can not be of particular assistance to agriculture. Therefore, it has all but disappeared from college curricula at least in a form to train students to know plants. Few agronomists and horticulturists graduating to-day from our agricultural colleges are well trained in botany—indeed so far as I know no college is training botanists to enter agricultural work, excepting along pathological lines.

I do not feel that I should be justified in thus painting so gloomy a picture of botany in its relation to agriculture, if the recent trend of things did not indicate that better times were coming—indeed are here. There was one field of work that both botanists and agriculturists entered upon in the course of their investigations that has brought them together, namely, plant breeding. It is a happy coincidence that at practically the same time the interest of all biologists has been stimulated to renewed interest in the problems of variation and heredity. The practical results already obtained by plant breeders is an earnest of what may reasonably be further expected. Incidentally but inevitably, the work of the plant breeder has stimulated interest in the matter of existing crop varieties as well as in the principles underlying variation and heredity. Breeding is, after all, largely the production of new varieties. Thus far, breeders have used for the most part locally established varieties as the basis of the work. This is sound as far as it goes, as the local varieties undoubtedly represent the best adapted of those tried, the poorer sorts having been discarded. It is safe to say, however, that but a small per cent. of existent varieties have been tried in most places—so that there may easily exist varieties superior at least in certain characteristics. A realization of this has led to a clearer appreciation of the value of a comprehensive study of the whole botany of our principal crop plants. This does not mean merely a categorical list of existent varieties—which it is evident can be indefinitely increased by hybridizing—but a sufficiently exhaustive study so that we may thoroughly understand the characteristics, both good and poor, that are available to the breeder. The task is by no means an easy one. In the first place, the number of varieties in all our crop plants is far greater than has commonly been realized. For example, there are probably about 2,000 varieties of wheat, 1,000 of beans, 5,000 of apples, 200 of sor-

ghums, etc. What is needed is not so much descriptions and detailed classification of these varieties, as a classification and understanding of their principal hereditary characteristics. In other words, the knowledge of them needs to be arranged not only with regard to the existing forms, but also as far as possible with regard to their characters and potentialities. Such a monograph does not exist for a single one of our principal crops, though there is an increasing number of contributions to the subject. The field is a vast one in which there is not only a great work to be done in compiling what is known of our cultivated plants, but a greater one in clearing up the many problems concerning their origin.

In a very different way plant breeding is beginning to do much to better agronomic methods. I have before stated that the most accurate plot work being done in this country is by the plots devoted to fertility investigations. How accurate are these? Hall, of Rothamstead, thinks no results with fertilizers are at all trustworthy unless the yield difference is at least 10 per cent. In much of the American breeding work going on 10 per cent. increase by selection would be deemed good progress. The question is, can any feasible system of trial plots measure accurately such a difference? Very recently several men have looked into this subject, more or less independently. The most comprehensive work has been done by Lehmann at the Mysore Experiment Station, India. Similar work has been done by Lyon at Cornell, Montgomery at Nebraska, Shoesmith in Ohio and Smith at Illinois. All of these investigators find a surprising difference in plots due to differences in soil. On what was considered the most uniform soil at the Nebraska Experiment Station the variation between plots on one acre was 35 per cent.—a much greater difference than the breeder of wheat expects to get. Lehmann found differences varying from 0 to 300 per cent —and further that on many plots the difference was increased or diminished according to the season. He proposes to use in his work with fertilizers only the plots that give uniform results for at least two similar seasons, a method that he calls *standardization*. In this country agronomists have used mainly the system of check plots—a system which it now appears may be absolutely misleading. Indeed, a study of the check plot records in various experiments shows that they vary in just the way that Lehmann found his plots to vary.

Some American agronomists are employing the method of duplicate plots—a plan that is rapidly growing in favor. The number of duplications for the most accurate work will necessarily vary according to the evenness of the soil, four to six duplications apparently being necessary for very accurate results even on fairly uniform soil. The subject is, however, one that needs much additional investigation, as the disturbing effects of soil inequalities have evidently been greatly underestimated.

The results of plant breeding seem likely, therefore, to have a profound effect on agronomy as a whole, demanding as it does both the most accurate plot methods to determine relative yields and a much more intensive knowledge of our crop plants—the material with which breeding must work.

There is still another botanical method that needs to be brought more intensively into agronomy—namely, the method of pure cultures, which has brought so great results in our knowledge of the lower plants. It is this method that enabled

Mendel to discover the phenomena that bear his name. Practical plant breeders now generally use the plant-to-row or centgener method in comparing the value of selected plants. It is probably due to the non-use of such careful methods that the origin of most cultivated varieties is so obscure. In many cases, a so-called sport or hybrid turns out to be a well-known thing—in all probability the result of a stray seed. This is perhaps unavoidable, as the business of the seed grower does not readily lend itself to accurate scientific methods.

Of late years our knowledge concerning hybrids and the behavior of characters in hybrids has increased greatly due to the rediscovery of Mendel's laws and the immense amount of splendid investigation which was thus stimulated. No more admirable body of work has ever been done than that of the Mendelists. If it continues as rapidly as it has we may soon expect to know approximately the extent to which hybridizing is a factor in the evolution of our cultivated plants. While the methods of the practical breeder are perhaps necessarily different or at least less accurate than those of the scientific breeder, yet the results of the scientific work are already having profound effect on practical methods.

Without at all minimizing the fruitful results and greater promises of Mendelian investigations, the subject of sports is to both the breeder and the evolutionist a matter of far greater moment. Certainly our knowledge concerning sports is far less than that of hybrids. The more enthusiastic Mendelists have evinced some disposition to deny the existence of "sports" in the commonly accepted sense and would explain them as the result of some previous, even remote, cross. But it is self-evident that hybrids presuppose the existence of two different things to cross, and sporting is supposed to be one method by which a distinct form more or less suddenly arises. Let us examine carefully the evidence regarding "sports." Bud sports, where one branch of a plant is different from the rest, occurring commonly as variations with differently colored flowers, different leaves, etc., are well known. There can be no question as to the origin of the sport here, though to be sure the parent plant may be a cross or hybrid. Seed sports are supposed to arise in an analogous manner. The general occurrence of certain types of assumed sports is strong argument in favor of their actuality. Thus, white-flowered variants are known in practically all plants with normally red or blue flowers; cut-leaved varieties are very common and generally distributed among the plant families; dwarf varieties occur in numerous species, as do smooth varieties in hairy species and vice versa. The logical inference is that the difference is due in each case to the same underlying cause. In some cases the origin of these sports is a matter of definite record, as in the case of the cut-leaved form of *Chelidonium majus*, the globose-podded form of shepherd's purse and others. In the white-flowered form of bleeding heart—its only variant—previous hybridization seems clearly excluded by the absence of any related form that will cross with it. Many such cases can be enumerated and tend to uphold clearly the gardener's idea of sports. But what are these sports, and how do they arise? Apart from the fundamental idea that they are large and permanent variations, breeders and gardeners in general attach three other ideas, namely, that high nutrition and other extreme conditions favor sporting; that many plants must be

cultivated a long time before sporting is induced, and that in any case sports are actually or relatively very rare. Will these ideas stand the test of scientific scrutiny experiments? It is evident that these problems are of high importance both to evolutionists and to agriculturists. De Vries with his *Œnotheras* and his theory of mutation as the chief factor in evolution has particularly interested the scientific world in these phenomena. He has worked out in great detail the facts of variation as they occur in the evening primrose and makes a strong case for his theory. Recent cytological study of the *Œnothera* mutants or variants shows that one of them has twice as many chromosomes as the others; in other words, that this mutant at least has suffered a pronounced change in its hereditary mechanism. It is only natural that this should at once have aroused the suggestion that perhaps all sports or mutants are the result of more or less marked derangement of the hereditary mechanism, by which a character or factor of some sort is gained or lost. MacDougal's work in subjecting very young ovules to chemical influences, and Gager's similar experiments with radium emanations, are also reported to have yielded marked variations, perhaps sports. Tower also secured true sports in increased numbers from his Colorado potato beetles by subjecting them to untoward conditions of heat and moisture during breeding. In this case, however, all the sports secured were previously found occurring naturally. There is a tempting subject here for speculation—indeed one that has been assiduously tilled, but to follow it up will lead us too far afield. The limited historical and experimental evidence of a critical character clearly upholds, however, the reality of sports.

It is an illuminating fact that most of the information concerning the origin of cultivated plants and animals is that brought together long ago by Darwin. Recently De Vries has gathered much additional data. Both these men sought the facts primarily in support of a theory. Scientific men are usually more concerned in finding an explanation of phenomena than in gathering the facts. But we can not all be philosophers and theorists—indeed, the principal difficulty with biological science is that we have a plethora of theory and a dearth of critical facts. Especially is this true in the subject of biological evolution, where nearly every possible guess and combination of guesses as to the actual method of evolution has been made. Where such guesses or theories stimulate additional inquiry they are valuable—otherwise, they are useful only to practise mental gymnastics. It is the great merit of many recent investigators, De Vries in particular, that they emphasize the importance of experimentation. De Vries's work bristles with suggestive lines of experimentation mostly bearing on the subject of the origin of cultivated plants, and nearly all of practical importance in agriculture as well of great interest in themselves. If any one believes that there is any immediate likelihood of biologists agreeing on evolution, all he has to do, using the slang of the day, is to start something. However much agreement there may be on the facts—there is sure to be violent disagreement on the interpretation of the facts. For example, De Vries and others believe that sports which usually breed true from the start are intrinsically different from ordinary or fluctuating variations induced by soil or otherwise and which have no effect on the offspring. On the other hand, Tower, who has conducted extensive investiga-

tions in the evolution of the Colorado potato beetle and its relations—work comparable to that of De Vries on *Œnothera*—argues strongly to show that his sports or mutations differ from fluctuations only in degree, not in kind. By definition, if the variant transmits its characters fully it is a mutation or sport; if not at all, it is a fluctuation. But many supposedly fluctuating variants transmit their characters in large part at least temporarily. Thus peas grown on warm or sandy soils are said to become mature earlier than the same variety planted on colder soils—and this difference is transmitted at least to their immediate progeny. It is believed to be in virtue of this supposed type of variation that northern grown seeds like corn often possess increased earliness when planted south; that continued selection as in sugar beets is necessitated to keep the plants to a high standard. Such plants clearly transmit to their progeny characters limited in both amount and duration. Are they then fluctuations or mutations? Those who hold that fluctuations have no effect at all on heredity, suggest that the sugar beet and kindred cases may represent complex polyhybrids continually breaking up and that rigid selection would, therefore, result in securing pure constant lines with high sugar content. Many mutations are at first partial, as in the cases of many double flowers. The first suggestion of doubling is often only a single additional petal. In the progeny of this individual some with more petals nearly always occur—and the process eventually results in full doubling. The general progress in these cases is seemingly parallel to what occurs in securing the pure lines out of a complex hybrid. A similar case if true is found in Burbank's red *Eschscholtzia*—the first hint of which was a red streak in the petals of a yellow sort. By continued selection the pure red was isolated. Professor Setchell tells me, however, that red-flowered eschscholtzias occur wild in certain localities in California. There is room for much discussion on all these points—but their settlement requires a larger body of critical facts than are yet available. There are plenty of gardeners' accounts of such phenomena to be had and they are probably true, but they do not possess scientific accuracy. Along these lines there is presented an alluring field of botanical work.

A clearer understanding of the different types or degrees of variation is most important. De Vries would recognize only three types, namely, fluctuations, mutations and ever-sporting plants. The latter include mostly plants with variegated leaves or flowers—which also constantly bear part of their leaves or flowers without variegation. A common example is the variegated-flowered larkspur. The azaleas with flowers on some branches red, on others white or striped, offer perhaps a similar phenomenon.

It is quite certain that such a classification simplifies the matter too much. Johannsen's work with beans clearly shows that mutations are often very small, even minute—but they are inherited—while similar variations not inherited are considered fluctuations.

De Vries's compilation of available evidence on the origin of plant sports tends to uphold in general the idea of the gardeners—namely, that sports are comparatively rare; that unusual conditions, especially of nutrition, favor their occurrence; and that often a plant must be cultivated a long time before it will sport. His evidence further shows that in some cases breeders sought out natural sports—and merely intensified their characteristics by cultivation. Whether De Vries's

theories are correct or not, wholly or partly, is of far less importance to agriculture than the stimulus he has given to the experimental study of plant variation. Not only has he done a vast amount of this sort of work himself, but he points out very clearly numerous problems awaiting the investigator.

It is remarkable that thus far so little has been done in attempting to produce anew the varieties of cultivated plants by beginning with the wild plant and conducting the work under critical scientific conditions. This is perhaps impossible in the case of our most important plants which have been cultivated since prehistoric times—and of whose original form we are in many cases ignorant, but it surely is a feasible and logical method of procedure in the case of plants domesticated in recent times, as is the case with many ornamentals. There is, I believe, no dissent from the statement that cultivated plants show far greater diversity than their wild progenitors. Is this greater diversity merely due to intensification of differences already possible of discernment in the wild plant, or do really new types appear under the stimuli of cultivation? To use a simple example, *Impatiens sultani*, an African ornamental, was first introduced into cultivation about twenty years ago, only a single color being then known. It now occurs in four distinct colors. Have these arisen under cultivation or were they found as wild sports? A more complex case. *Phlox drummondii* is a native to Texas and not very variable, so far as known only pink, purple and red varieties existing wild. It was introduced into cultivation about seventy-five years ago. There is now a bewildering array of color varieties—both with entire and with fringed petals. In the so-called star of Quedlinburg varieties the central tooth of the fringed varieties is prolonged into a lobe as long or longer than the petal. In the wild form there is apparently no hint of such a character. It ought to be no difficult task to repeat the evolution of these forms under test conditions and thus get a full record of what takes place. Until this is done our picture of the process must remain incomplete. How far extreme conditions as to soil, heat, moisture and other external factors may affect the process of variation, especially permanent variations, is one of great interest and importance. Our wide range of soils and climates gives us unusual opportunity to plan such investigations. To start anew with the wild forms of our most important crops, wheat, oats, corn, beans, potato, etc., is rendered difficult owing to our ignorance of the wild progenitors of these crops. Why these should have disappeared if such is the case is very puzzling. Aaronsohn has recently discovered in the mountains of Palestine what are probably the wild originals of wheat, of barley and of rye. As this country was long ago well explored botanically, the question at once arises—why were not these plants found? Aaronsohn offers a humorously simple explanation, namely, that no botanist ever collects a cultivated plant and no agronomist ever looks at a wild one. Perhaps a similar explanation may account for our ignorance of corn and other American natives in the wild state. A particular interest in knowing the wild form of such plants is to be able to measure the progress that has been made by cultivation. Another is to determine how quickly it may be possible to breed up to the approximate standards of the long-cultivated strains. There is a general belief that great improvements can be made in the early processes of breeding for improve-

ment but that these rapidly and progressively become less and less with each step in advance. This is perhaps true as it is a general law of nature. Yet the improvement made in some supposed cases is vastly greater than could possibly have been anticipated. Thus the gap from Johnson grass to its supposed derivations, such as Kafir, Jerusalem corn, milo, Sumac sorghum and a host of other varieties is so great as to stagger one's belief. Yet the botanical evidence is good enough to warrant critical experimental investigation.

How much further wheat, corn and other long-cultivated plants may still be improved can not be foretold, because we are too ignorant of the potentialities which have brought them to their present development. In any attempt that may be made to redevelop the cultivated forms from the wild forms, two things will have to be considered—first, that various forms of the wild plant may and probably do exist in different regions—and second that even beginning with the same wild form its descendants in different regions will probably vary in different directions. Only on one or both of these hypotheses can we explain the fact that with anciently cultivated plants each region has its own peculiar varieties and types. The problem of the origin of the more marked varieties of the plants cultivated in and since prehistoric times becomes an exceedingly complex one, probably capable of being duplicated only in small part. We must not underestimate the ability of even very low races of agricultural people to improve their cultivated plants. Certainly the Indians developed corn to a very high degree and had some pretty clear ideas regarding its culture. For example, the Virginia Indians made it a point to plant in each hill seed from several different ears.

It seems to me that we too often err on the side of making phenomena appear more simple than they really are. Plants are vastly more complex organisms than our formulated ideas recognize. Many of their phenomena completely baffle us. For example, I might mention what has been called aggressiveness in a plant—namely, its ability not only to occupy and maintain the soil, but to spread and crowd out other plants. This is particularly evident in plants introduced from one country to another. Thus nearly all of our weeds are of old world origin. The same is true of our permanent meadow and pasture plants, where ability to occupy and hold the ground against weeds is essential. In this respect our American grasses and clovers utterly fail before the foreign immigrants. Some other striking instances of the great aggressiveness of an immigrant may be cited. The introduced English violet is said to be the worst of weeds in Mauritius; American cacti are becoming a pest in South Africa; the marvelous vigor and spread of the American waterweed (*Elodea*) under European conditions is well known. Several explanations of these and similar phenomena have been advanced. The commonest one is that the plant is introduced but its fungous and insect enemies are not. Therefore, the plant is released from all handicaps as it were and can exercise to the utmost its inherent energy. A second and related explanation is that every plant becomes held within limits by the competition of other plants in its native land, and very often in the new environment the native plants do not have an equal restraining influence—because they have had to contend with a different set of competitors. A third idea is that any organism with the ability to

spread at all becomes more energetic through the constant mixing of blood of the advancing population. All these ideas are interesting, but difficult, if not impossible of experimental proof. The last suggestion receives some support from the fact that many weeds and other organisms "peter" out after they have ceased to spread. The recent examples of the Russian thistle and the prickly lettuce are familiar cases. Such phenomena may be due wholly or in part to increase in enemies —but in many cases like the two cited there is no iota of positive evidence. I think we ought to give such phenomena more consideration, as they reveal traits in plants that transcend all of our stereotyped and inadequate theories. The old gardener often treats his plants as if he regarded them as sentient beings. Perhaps we err in considering them too much as machines.

I have touched thus much on the botany of our cultivated plants and their origin and behavior under domestication because I believe that there lies here a great field for botanical and agricultural advancement. It matters not what we call this phase of botany—its successful prosecution demands both broad and intensive botanical training. It requires at least a good knowledge of systematic botany, of plant physiology and of the theories and principles of plant breeding and plant evolution. One must at least know all the botany possible of the plants he is immediately concerned in breeding, lest he be lured into needless error. Among his many experiments, Mr. Oliver has made some very interesting hybrids of *Poa arachnifera,* the Texas bluegrass and Kentucky bluegrass, a circumboreal plant. His culture soil was presumably sterilized, yet mixed with his hybrids were plants of Canada bluegrass, *Poa compressa.* One enthusiastic Mendelist was jubilant over the supposed discovery of the origin of this grass and at once proposed an additional series of experiments. Now *Poa compressa* is a European species—and the securing it by crossing a Texas species with common bluegrass was certainly a startling phenomenon. Fortunately or perhaps unfortunately, some of the other supposed hybrids in the lot turned out to be other grasses, including timothy and sweet vernal grass, so that the source of the error was evident. It points, however, clearly to the necessity of the scientific breeder knowing the systematic botany at least of the group he is working with.

I well recall that when I first began to study plants I promptly found about a dozen species of red clover—at least they were different from each other. It took a long time to teach me that in plants there were differences and differences, some of which should be taken seriously and others ignored. In general, I was taught that any differences that existed in closely related cultivated plants were to be ignored, but in wild plants they would usually have to be considered. It is really very fortunate for the cultivated plants that systematic botanists have not taken their differences seriously, otherwise we would have chaos indeed. It is unfortunate that the conservatism which most systematic botanists exhibit toward cultivated plants should not be exhibited as well toward wild plants. If more attention had been given to the cultivated plants, think what a vast host of reputed wild species would have escaped the pangs of christening. There used to be hope that after a while all the species would be described—so that systematic botanists could devote themselves to deeper studies. But alas, it seems only necessary to make finer distinctions to reveal a wondrous display of so-called species where

none was seen before. It, therefore, seems inevitable that a new race of systematic botanists will have to be developed to devote themselves to cultivated plants—for it needs no seer to predict that many generations of botanists will be needed to define and describe all the minute forms in nature which it is now proposed to call species. The fatuity of such work, however, will defeat itself. As a matter of fact, the naming of a species is an interpretation of facts just as our theories of variation are interpretations of the same or very similar facts. For both purposes we need far more of the facts that can only be gathered in rigid pedigreed breeding experiments. Botanists have too long neglected the most vital features of botany to the theoretical evolutionist and to the commercial breeders. We have developed to a high degree nearly every phase of the subject that does not touch industry—and have neglected those of most practical import. Our hope of aiding the art of agriculture is in developing its underlying sciences. Too many of us have reversed this idea and think to help the sciences of agriculture by devoting more attention to its art. But gardeners do things with plants that are the despair of the physiologist, and there always will be vastly better farmers than the scientists.

The matter of botanical instruction in all schools is to a large extent a matter of fashion—and the fashion is usually set by the larger universities, where no attempt is made to give botany an industrial trend. There has thus been developed a splendid lot of texts on morphology, embryology, systematic botany, physiology, etc., but none of this material has been presented in its agricultural bearing, and consequently the field of botany in agriculture has not been clear. At the present time it has neither direction nor aggressiveness. What we really need to work on is the science of the breeder's art and the science of the gardener's art. At present, the art is far in advance of the science. In fields where the agricultural art was not highly developed—notably pathology and bacteriology—the botanist has accomplished great things. Greater things remain in the botanical fields he has thus far so largely neglected. If we pursue agriculture or any phase of it without devoting our science to it, we can at most become expert farmers. By devoting our science to agriculture and having faith in its potency, no man can foretell the outcome.

I have endeavored to indicate what I regard as the most promising lines for botanical work to advance agricultural progress. The routes that the investigators have followed and are following along these lines furnish the natural and best possible chart upon which to map botanical courses in agricultural schools. These courses should be fashioned as far as possible to promote interest in the botanical problems of agriculture, rather than those with little or no agricultural contact. To me it seems as if the great field that is at present open to us is that of determining as fully as possible the potentialities of our principal crop plants so that they may be utilized to the utmost.

In some ways we might compare our present knowledge of plant species or their subdivisions to the knowledge of organic chemistry fifty years ago. At that time it was believed that organic compounds could be formed only by vital processes. In a similar way there exists among biologists the more or less unformulated idea that species and subspecies are the result of forces beyond our command; that we can study their evolution but can not control the processes. It seems to me that the results obtained by the cultivator of plants

and the domesticator of animals virtually contradict this idea, enough so at least that there is good basis for De Vries's bold prediction:

A knowledge of the laws of variation must sooner or later lead to the possibility of inducing mutations at will, and so of originating perfectly new characters in plants and animals. And just as the process of selection has enabled us to produce new races, greater in value and in beauty, so a control of the mutative process will place in our hands the power of originating permanently improved species of animals and plants.

C. V. Piper

Washington, D. C.,
March 5, 1910

SCIENTIFIC NOTES AND NEWS

Following the advice of its advisory board, The Wistar Institute of Anatomy is about to extend its work by the establishment of a department of embryology. At a meeting of the board of managers of the institute, held May 27, a professorship of embryology was established, and Professor G. Carl Huber, of the University of Michigan, was called to this chair. Professor Huber will begin his work at the Wistar Institute in 1911.

Dr. William Colby Rucker, of the United States Public Health and Marine-Hospital Service, has been granted leave of absence for one year to accept the position of health commissioner of Milwaukee.

Dr. C. F. Lorenz, formerly of the Queen's University, Kingston, Ontario, has entered upon the duties of his position as associate physicist in the Physical Laboratory of the National Electric Lamp Association. Mr. A. G. Worthing, of the University of Michigan, and Mr. M. Luckiesh, of the University of Iowa, have also accepted appointments in the laboratory.

Mr. Jerome D. Greene, secretary of the Harvard College Corporation, has been appointed superintendent of the Rockefeller Institute for Medical Research and its new hospital.

Dr. Aleš Hrdlička has been promoted to a curatorship of anthropology in the U. S. National Museum. He has started for South America to carry on some work in Peru and Bolivia and to attend the Congress of Americanists.

Columbia University has conferred its doctorate of science on Sir William Henry White, for many years director of naval construction of the British navy, and on Dr. W. J. Mayo, the eminent surgeon of Rochester, Minn.

On the occasion of the installation of the Duke of Devonshire as chancellor of the University of Leeds, the degree of doctor of science was conferred on Lord Rayleigh, Sir Clements Markham and Professor William Osler.

Lord Rayleigh has been promoted from a corresponding to a foreign member of the Berlin Academy of Sciences.

Dr. W. Solomon, professor of geology at Heidelberg, has been elected a foreign member of the Academy of Sciences in Milan.

The two eminent pharmacognosists, Professor Arthur Meyer, of Marburg, and Professor A. Tschirch, of Bern, were elected honorary members of the American Pharmaceutical Association at the recent meeting in Richmond, May 3–7, 1910.

Dr. Rollin D. Salisbury, professor of geographic geology at the University of Chicago, has been elected president, and Dr. Henry C. Cowles, assistant professor of plant ecology, first vice-president, of the Geographic Society of Chicago.

The American Philosophical Society has appointed its president, Dr. William W. Keen, to represent it at the Centennial Jubilee of the University of Berlin to be held in October next.

Professors Sollas and Bowman have been appointed university representatives from Oxford University to the eleventh International Geological Congress, to be held at Stockholm.

The Barnard Medal was awarded at the commencement exercises of Columbia University to Professor Ernest Rutherford, director of the physical laboratories, University of Manchester. This medal, established

by the provisions of the will of President Barnard, is awarded quinquennially for discovery in physical or astronomical science, or the novel application of science to purposes beneficial to the human race, which in the judgment of the National Academy of Sciences shall be esteemed most worthy of such honor. The award of 1895 was to Lord Rayleigh and Professor William Ramsay; that of 1900, to Professor Wilhelm Conrad von Röntgen, and that of 1905, to Professor Henri Becquerel.

THE friends and former pupils of Mr. A. E. Shipley, of Christ's College, Cambridge, propose to present him with his portrait, in recognition of his "services to zoological teaching and research, and his eminent usefulness to the University and to his college." The portrait will be painted by Mr. William Nicholson.

PROFESSOR HELLER, director of the Pathologic Institute of Kiel, celebrated his seventieth birthday on May 1.

MR. FERDINAND ELLERMAN, in charge of the expedition organized by the Astronomical and Astrophysical Society of America to observe Halley's comet in the Hawaiian Islands, reports that in spite of unfavorable weather conditions he has obtained a set of excellent photographs of the comet. No trace of the comet's head could be seen while in transit over the sun, although it was carefully sought under favorable atmospheric conditions.

PROFESSOR R. W. WOOD, of the Johns Hopkins University, Baltimore, who will spend next year abroad, will give, in London, the Thomas Young oration of the Optical Society and the Traill Taylor lecture before the Royal Photographic Society.

M. JEAN CHARCOT has returned to France on the *Pourquoi Pas* from his Antarctic expedition.

DR. CHARLES PEABODY, of Harvard University, has returned from North Carolina, where, during the month of May, he explored two groups of small mounds in Cumberland County, near Fayetteville.

DR. E. GRAWITZ, professor of pathology at Berlin, will visit this country in the autumn and deliver an address before the New York Academy of Medicine on "Pernicious Anemia."

ON May 31, Mr. C. J. Holmes gave the first of two lectures at the Royal Institution on "Heredity in Tudor and Stuart Portraits"; on June 2, Major Ronald Ross gave the first of two lectures on "Malaria," and on June 4, Professor J. A. Fleming began a course of two lectures on "Electric Heating and Pyrometry," these being the Tyndall lectures.

DR. W. S. BRUCE, leader of the Scottish Antarctic expeditions of 1902–04 and 1911, gave a lecture, with lantern illustrations, on "Antarctic Exploration" at Oxford University on May 27.

PROFESSOR VICTOR BJERKNES, of the University of Christiania, gave a lecture on "The Synoptical Representation of Atmospheric Motions," at University College, London, on May 27.

GENERAL CYRUS BALLOU COMSTOCK, U. S. A. (retired), the eminent engineer, member of the National Academy of Sciences, died on May 29, at the age of seventy-nine years.

LIEUTENANT BOYD ALEXANDER, known for his important scientific explorations in Africa, was killed by natives in the Soudan, on April 2.

MR. J. B. N. HENNESSEY, F.R.S., known for his surveys and other scientific work in India, died on May 23, at the age of eighty years.

M. BERNARD BRUNHES, the director of the observatory of the Puy de Dôme, known for his researches in meteorology, has died at the age of forty-seven years.

DR. SALVATORI LO BIANCO, of the Zoological Station at Naples, has died at the age of fifty years.

M. GREHANT, professor of histology of the Museum of Natural History and director of the laboratory of the Ecole de Hautes Etudes, has died at the age of seventy-two years.

WE learn from the London *Times* that a number of visitors inspected the National Physical Laboratory at Teddington on March 18, by the invitation of Sir Archibald Geikie,

the president of the Royal Society, who is chairman of the general board. Those present included Lord Crewe, Lord Rayleigh, Sir J. Wolfe Barry, Sir Joseph Brunner, Sir William White, Sir Philip Watts, Sir Joseph Larmor, Sir John Thornycroft and Sir Gerard Muntz. The report states that last year the income amounted to £24,270, as against £21,871 in the previous year. Of this nearly £2,000 was due to the treasury grant for aeronautical work from June to December, and the fees for tests, etc., carried out rose from £13,088 to £14,240. The executive committee expresses the opinion that the time has now come when the interests of meteorology, terrestrial magnetism, etc., will be best served by separating them from the research and test work of the laboratory, the application of science to engineering, electrotechnics, naval architecture, etc.; and a report to this effect, embodying a scheme by which the change may be effected, has been transmitted to the treasury, by which it has been favorably received. The committee has also prepared a scheme, involving an estimated expenditure of £30,000, for providing the additional buildings required for carrying out this change satisfactorily, and also for increasing the inadequate accommodation for certain departments, particularly metallurgy and the general administration of the laboratory.

We learn from *Nature* that a grant of £100 from the Worts Fund, of Cambridge University, will be made to Mr. E. A. Wilson, of Gonville and Caius College, who has been entrusted with the organization of the scientific department of the British Antarctic Expedition, 1910, towards defraying the expense of the equipment. The scientific staff of the expedition includes Messrs. D. G. Lillie, of St. John's College; E. W. Nelson, of Christ's College; T. G. Taylor, of Emmanuel College; E. A. Wilson, of Gonville and Caius College, and C. S. Wright, of Gonville and Caius College. Grants of £50 to Mr. C. E. Moss, curator of the University Herbarium, towards defraying the expense of botanical investigations which he proposes to make on the continent of Europe, and of £25 to Mr. R. H. Rastall, towards defraying the expense of a visit which he proposes to make to South Africa for the purpose of carrying on geological investigations, will also be made.

The April number of the *Journal of Home Economics* is largely devoted to a discussion of various phases of the school lunch question by nearly a score of writers. There is an article on school feeding in Europe by Miss Louise Stevens Bryant, who is in charge of the School Feeding Inquiry of the Russell Sage Foundation; Dr. Ira S. Wile writes on the general problem, while other articles furnish accounts of experiments that have been made in Philadelphia, New York and Boston. An interesting symposium is published on economy of materials in school lunches, containing in detail the practical working out of the problem in different parts of the country. Ignorance in the homes of the poor as a contributing cause of malnutrition of the children is a subject treated by Miss Gibbs of New York and Miss White of Baltimore, together with the remedy which has already proved effective in New York, that is, the work of the visiting dietitian. The American Home Economics Association which publishes the *Journal of Home Economics* aims "to improve the conditions of living in the home, the institutional household and the community," and unites all actively interested in home problems.

UNIVERSITY AND EDUCATIONAL NEWS

At the commencement exercises of Bryn Mawr College it was announced that the college had obtained money sufficient to pay its debts, and in addition \$250,000, which entitled it to the appropriation of \$250,000 of the General Education Board. The sum raised by the Alumnæ Association was \$304,900 which is to be used for the endowment of chairs in mathematics, English and economics.

The legislature of Maryland has made an appropriation of \$25,000 a year for 1911 and 1912 for the Johns Hopkins University.

The Jefferson Medical College has purchased the building formerly occupied by the Pennsylvania College of Dental Surgery at

Eleventh and Clinton streets, Philadelphia, and will use it for laboratory purposes.

THE late Sir Donald Currie's daughters, Mrs. Mirrilees and Mrs. Percy Molteno, have given a sum of £25,000 to the University of Cape Town for the construction of a hall as a permanent memorial to Sir Donald Currie.

THE alumni of Brown University by a vote of 2,008 to 223 favor the removal of the denominational restriction which requires the president and the majority of the trustees to be baptists.

IT is reported that from the answers to several hundred letters sent by Yale University to heads of preparatory schools and public high schools, the majority favor science and history as substitutes for Greek at the entrance examinations of the academic department. The changes will, it is said, probably be adopted at the entrance examinations in 1911.

DR. GEORGE BLUMER, professor of medicine, will succeed Dr. Herbert E. Smith as dean of the Yale Medical School.

MR. H. N. EATON, instructor in geology in the University of North Carolina, has been appointed to a similar position in the School of Mines, University of Pittsburgh.

SCIENTIFIC BOOKS

Charles Darwin and the Origin of Species. By E. B. POULTON. London and New York, Longmans, Green & Co. 1909.

Professor E. B. Poulton, Hope professor of zoology in Oxford University, has long been known as the leading proposer and defender of theories of mimicry, warning, directive and recognition coloration and the like. Next to the names of Bates and Müller, which are names of the pioneer observers and hypothesis makers in this field, stands the name of Poulton.

The name must now be associated with another distinction; it is that of the most loyal present-day disciple of Darwin. Poulton is a whole-hearted accepter and ardent defender of everything that came from the mouth and pen of his immortal master. There are no mental reservations about Professor Poulton's Darwinism; no interpretations other than the obvious ones; no buts nor howevers.

In his addresses (which I have referred to recently in other pages of this journal) at Baltimore in January, 1909, before the American Association for the Advancement of Science, and at Cambridge in June of the same year at the great Darwin Commemoration Meeting, Professor Poulton was the conspicuous exception among the other speaking biologists in his unreserved acceptance and defence of Darwinian selection as the all-important factor in species-forming and evolution. He now appears as the author of a book explicitly given to the exposition and defence of this factor and to the answering of its critics.

The book comprises the two addresses already mentioned, together with two lesser ones given as banquet speeches on the same general occasions; another given at the Oxford Darwin celebration in February, 1909; an anniversary address given in December, 1908, before the Entomological Society of America in Baltimore; a group of about twenty hitherto unpublished letters written by Darwin to Roland Trimen between 1863 and 1871; and four brief appendices including notes on Darwin and the hypothesis of multiple origins, Darwin and evolution by mutation, Darwin's health and work, and De Vries's fluctuations as inconsistently treated by certain English believers in them. The whole collection is the consistent utterance of a perfect Darwinian.

The new Darwin letters do not add much to our knowledge of the master's personality, but they are interesting. They are full of glimpses of hard and constant work and continuous and interfering ill health. They touch especially—and this is their particular interest to Professor Poulton—the subject of color and pattern (Trimen was a devoted observer in this field). All the references to this subject are, however, tinged with the sexual selection hypothesis which was more importantly in Darwin's mind than any hypoth-

esis of mimicry or the like. There are some very quotable bits in the letters. In a letter of April, 1868, Darwin writes:

Many thanks for your Photograph, and I send mine, but it is a hideous affair—merely a modified, hardly an improved, Gorilla.

Mr. Trimen's first meeting, or rather first seeing, of Darwin, as described by him in a letter to Professor Poulton, is an interesting reminder of the reality of the heresy of the "Origin" in its first days.

It was in the Insect Room of the Zoological Department of the British Museum that I had my first glimpse of the illustrious Darwin. Towards the close of 1859, after my return from the Cape, I spent much time in the Insect Room identifying and comparing the insects collected with those in the National Collection. One day I was at work in the next compartment to that in which Adam White sat, and heard some one come in and a cheery, mellow voice say, "Good morning, Mr. White; I'm afraid you won't speak to me any more!" While I was conjecturing who the visitor could be, I was electrified by hearing White reply, in the most solemn and earnest way, "Ah, Sir! if ye had only stopped with the 'Voyage of the Beagle'!" There was a real lament in his voice, pathetic to any one who knew how to this kindly Scot, in his rigid orthodoxy and limited scientific view, the epoch-making "Origin," then just published, was more than a stumbling block—it was a grievous and painful lapse into error of the most pernicious kind. Mr. Darwin came almost directly into the compartment where I was working, and White was most warmly thanked by him for pointing out the insects he wished to see. Though I was longing for White to introduce me, I knew perfectly well that he would not do so; and after Mr. Darwin's departure White gave me many warnings against being lured into acceptance of the dangerous doctrines so seductively set forth by this most eminent but mistaken naturalist.

A little while afterwards, on the same day, I again saw Darwin in the Bird Galleries, where it was, I think, G. R. Gray who was showing him some mounted birds. A clerical friend with me, also a naturalist, curiously enough echoed White's warning by indicating Darwin as "the most dangerous man in England."

The most interesting of Professor Poulton's personal contributions to his volume are two papers treating the special subject of his studies, namely, the addresses on "The Value of Color in the Struggle for Life" and "Mimicry in the Butterflies of North America." One is a suggestive general treatment of the use-of-color subject, the other a detailed special consideration of a suggestive set of illustrations of one phase of this subject. As an entomologist acquainted somewhat with the alleged mimicry case from the Pacific Coast which to Professor Poulton seems to be, if really proved, "one of the most interesting and instructive examples of mimicry in the world," viz., the resemblances between *Limenitis californica* and *L. lorquini*, I can only say that much more evidence than at present has been collated is necessary before this case can receive general acceptance. But this Professor Poulton also recognizes fairly, so any present hesitancy to see the pertinence of this example of mimicry can not be misconstrued by its sponsor. What is needed in this case is exactly stated by Professor Poulton, viz., "extensive investigations in America."

V. L. K.

STANFORD UNIVERSITY, CAL.

Illustrations of African Blood-Sucking Flies other than Mosquitoes and Tsetse Flies. By ERNEST EDWARD AUSTEN, Assistant in the Department of Zoology, British Museum (Natural History), with colored figures by GRACE EDWARDS. London. 1909. Pp. 221, 13 colored plates.

Repeated demonstration of the agency of blood-sucking insects in the transmission of certain diseases invests with the greatest practical importance an accurate knowledge of the genera and species of these forms. Warfare against such diseases is now being carried on with great vigor in Africa and the volume under consideration has been prepared with a view to aiding in this contest.

In the preface the author mentions the plan of a general monograph on the blood-sucking insects which was originated by Sir E. Ray Lankester, when director of the natural history departments of the British Museum. Four volumes on mosquitoes, by F. V. Theobald,

were issued between 1901 and 1907, one, in which tsetse flies were treated by E. E. Austen, in 1908, and now this volume by the same author covers the remainder of the Diptera.

With the exception of Egypt the territory covered in this work falls within the limits of the zoogeographic province ordinarily called the Ethiopian region. The record is confessedly incomplete, even for the region indicated, as the material available was at best scanty, so that data concerning detailed distribution which are given in the last chapter of the book are of relatively little value. This defect, which is commented upon briefly only in the preface, is of a serious character, since many of the medical and military men who will be called upon to use the book are likely to draw unwarranted, though none the less unfortunate, inferences from the brevity of the records, but even more serious difficulties arise from the omission of any reference to those species not illustrated here.

As natural in a work dealing with forms that have so recently attracted particular attention, museum material from different countries is sure to be variable in amount and the records compiled therefrom of very unequal value. Cape Colony naturally leads in number of species recorded and Uganda is a close second, but some states have only three or four species listed, *i. e.*, are represented by very little material in the museum collections and yet the text of this chapter conveys no hints as to the proper method of interpreting its lists.

Of the Chironomidæ the work describes and figures one genus including three species; of the Simuliidæ, one genus with four species; of the Psychodidæ, one genus with a single species; of the Tabanidæ, seven genera with eighty-four species; of the Muscidæ two genera with five species, and of the Hippoboscidæ one genus with three species. These represent less than one half of the African species already known. The illustrations are very successful and in practical work will be of immense value. Synoptic keys as well as specific and generic descriptions are entirely omitted and reliance placed rightly upon the accuracy of the figures which are admirably done. The habitus and coloration of the species figured are vividly represented, even though few structural features are distinguishable in the plates.

The author handles the bionomics of the group treated in the broadest possible manner, always from the point of view of disease dissemination, and the records of work done by other investigators are particularly full and well digested. In fact, the text is a mine of information concerning the breeding, feeding habits, appearance and relation to disease of the individual families, genera and species. The work is evidently well done and bears the earmarks of accuracy. It also stands the test as regards completeness of data concerning the species treated.

The book is certainly popular—in the best sense of the word—rather than scientific, and is sure to prove very valuable to investigators experimenting on suspected species in the field. It is also an important reference work for those interested in this group either as students of Diptera, of medical zoology, or of disease transmission through insects.

HENRY B. WARD

Aposporie et Sexualité chez les Mousses, II. Par EL. et EM. MARCHAL. Bull. de l'Acad. roy. de Belgique (Classe de sciences), No. 12, pp. 1249–1288. 1909.

In previous papers on mosses the Marchals have shown that the differentiation of sex in certain diœcious species takes place in the formation of spores in the sporangia, a single sporangium containing both male and female spores; further, that a regeneration obtained from the cells of the sporophyte of a diœcious species before the formation of spores will develop into an hermaphroditic growth and produce both archegonia and antheridia.

The present paper deals with the sexual character of the products of apospory or these sporophytic regenerations. As might be expected, the aposporic outgrowth induced from a mutilated young sporangium is found to agree with the sporophyte in the number of chromosomes in its cells, and with $2n$ chromo-

somes may therefore be classed as a diploid growth in distinction to the original gametophytic or haploid stage with its $1n$ number of chromosomes. These diploid growths of diœcious (heterothallic) species remain entirely sterile, though producing apparently normal antheridia and archegonia. Attempts made to produce hybridization between these hermaphroditic diploid growths and male and female plants of the normal $1n$ generation resulted in failure.

With hermaphroditic (homothallic) species the condition is different and the aposporic outgrowths are fertile. Their gametes with $2n$ chromosomes unite and produce sporophytes with $4n$ chromosomes. These tetraploid sporophytes form spores with again $2n$ chromosomes, which grow into fertile gametophytes with double the normal chromosome number, thus producing a definitely fixed bivalent race (*e. g., Amblystegium serpens bivalens*). The regeneration from the tetraploid sporophyte gives rise to a race with $4n$ chromosomes which as yet has remained sterile. A sporophyte with $8n$ chromosomes might be produced if this $4n$ race could be induced to fruit.

No phenomena have been observed, such as apogamy or supplementary chromosome reduction, which would avoid the doubling of chromosomes in the races obtained from sporophytic regenerations.

A rather careful series of measurements were made of the size of the nuclei and cells in the different stages obtained, and it was found that the volume of the cells and of the nuclei were directly proportional to the number of chromosomes in the $1n$, $2n$ and $4n$ gametophytes as well as in the $2n$ and $4n$ sporophytes. Further, it was seen that this increase in size of the cells with an increase in the number of chromosomes resulted in the enlargement of certain organs such as the antheridia and archegonia.

The Marchals believe that apospory is likely to occur in nature from wounding of the sporophyte and that bivalent races have thus been formed.

There is promised a continuation of these investigations on the mosses which have proved already of such great interest to the students of sex.

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A List of Geographical Atlases in the Library of Congress, with bibliographical notes. Compiled under the direction of Philip Lee Phillips, F.R.G.S., Chief Division of Maps and Charts. In two volumes, cloth: Vol. I., Atlases, pp. xiv + 1,208, Vol. II., Author List, Index, pp. 1,209–1,659. Washington, Government Printing Office. 1909. $2.35.

In the publication of these volumes a very commendable service has been done for geography and for students in all lines making use of maps. For it is strictly true as the editor says in his preface, "atlases have not received the consideration in bibliography due to their importance in literature and as contributions to knowledge." There are few works on the subject and these are fragmentary.

The present contribution is merely a list of the geographical atlases in the Library of Congress, a total of over thirty-four hundred titles in addition to seventy lettered titles. The editor modestly disclaims it as a bibliography.

The arrangement is good. It starts with general atlases of special subjects, the subject headings in alphabetical order. Then follow the general atlases in chronological order, and then follow America, Europe, Asia, Africa and Oceanica in similar order. This classification includes under each general heading the atlases of cities, of voyages of circumnavigation, historical works, scientific explorations, and the atlas material accompanying the reports on boundary disputes between nations.

Bibliographical notes and tables of contents have been given in case of the rare and more important volumes. This brings out numerous inserted maps, so frequently hidden away in such material.

In the second volume the general index is preceded by an author index of abridged titles, in which the author's full name is

given, and dates of birth and death, where known. The importance of the latter is evident, as a clue to the dates of publication, for it has been the custom among most map publishers to omit the date. For obviously, since people as a rule are not very particular about maps, and know very little about them, it has always been a temptation to the publisher to make an old plate do in a new publication.

As no other library "has published a complete description of its atlas material it is impossible to state authoritatively how the collection in the Library of Congress compares in size and importance with others." But these two volumes certainly attest to long and assiduous collecting. To start at the beginning, of the forty known editions of Ptolemy, all but three are in this collection. In cartographic material relating to America the collection is especially rich and complete.

To all students in geography and history, these volumes will come as a welcome instrument of research. It will be of the highest value to be able to turn to the index for a place name, and to find there listed every atlas in the collection pertaining to the region, and in the more important publications to find even the description of every map in the atlas of the region. It will save endless search and will settle in a minute at your own desk, whether or not you have all the available material bearing on your particular quest.

Yet a hasty scanning of the collection seems to show a shortage of the most recent published material. And it raises the question, whether or not the appropriations for this division are generous enough to permit the acquisition of such fine atlas material as is available from the working presses of the day in the various lands. These two volumes at once will turn the attention of all the country to this collection, and it will be looked to whenever a map or atlas is desired. It is likely to raise uncomfortable questions when some of the best modern material from various lands is not found listed.

J. PAUL GOODE

UNIVERSITY OF CHICAGO,
May 23, 1910

SCIENTIFIC JOURNALS AND ARTICLES

THE April number (volume 11, number 2) of the *Transactions of the American Mathematical Society* contains the following papers:

Edward Kasner: "The theorem of Thomson and Tait and natural families of trajectories."

F. W. Owens: "The introduction of ideal elements and a new definition of projective *n* space."

Arthur Ranum: "The groups of congruent quadratic integers with respect to a composite ideal modulus."

G. D. Birkhoff: "A simplified treatment of the regular singular point."

L. M. Hoskins: "The strain of a gravitating, compressible elastic sphere."

THE May number (volume 16, number 8) of the *Bulletin of the American Mathematical Society* contains: Report of the February meeting of the Society, by F. N. Cole; Report of the February meeting of the San Francisco Section, by C. A. Noble; "An application of the notions of general analysis to a problem of the calculus of variations," by Oskar Bolza; "The infinitesimal contact transformations of mechanics," by Edward Kasner; "On an integral equation with an adjoined condition," by Anna J. Pell; "The unification of vectorial notations" (review of Burali-Forti and Marcolongo's Calcolo vettoriale and Omografie vettoriali), by E. B. Wilson; Shorter notice of Meyer's Allgemeine Formen- und Invariantentheorie, volume 1, Binäre Formen, by Virgil Snyder; "Notes"; "New Publications."

THE June number of the *Bulletin* contains: Report of the April meeting of the society, by F. N. Cole; Report of the April meeting of the Chicago Section, by H. E. Slaught; "Groups generated by two operators each of which is transformed into a power of itself by the square of the other," by G. A. Miller; "The solution of an integral equation occurring in the theory of radiation," by W. H. Jackson; Review of Grassmann's Projective Geometrie der Ebene, by L. W. Dowling; Review of Schlesinger's Lineare Differentialgleichungen, by E. J. Wilczynski; "Shorter notices": Bonola's

Geometria noneuclidea and Liebmann's German translation, by Arthur Ranum; Nichol's Analytic geometry, revised edition, and Wentworth and Smith's Complete arithmetic, by G. H. Scott; Wangerin's Theorie des Potentials und der Kugelfunktionen, by J. B. Shaw; Timerding's Geometrie der Kräfte, by W. R. Longley; "Notes"; "New Publications."

BOTANICAL NOTES

FORESTS AS GATHERERS OF NITROGEN

At a meeting of the Society of American Foresters, on March 31, 1910, a paper was read by Mr. Treadwell Cleveland, Jr., on "Forests as Gatherers of Nitrogen." This paper summarized results recently obtained by Jamieson, of Scotland, and by Zemplen and Roth, of the Royal Hungarian Experiment Station at Selmecbanya, which tend to show that forests are able to appropriate free atmospheric nitrogen by means of their trichomes. Jamieson investigated several forest trees (as well as a number of smaller plants), among which were *Acer campestre, Tilia europaea, Ulmus campestris, Sorbus aucuparia, Fagus silvatica* and *Picea concolor*. Zemplen and Roth included a large number of additional species. In all cases chemical tests show the presence of nitrogen in the trichomes, and the investigators believe that they have excluded all other sources for this nitrogen than the atmosphere. Professor Henry, of the Forest School at Nancy, France, was the first to point out that forest soils are enriched in nitrogen by the decay of fallen leaves.

Zemplen and Roth are cautious in their conclusions, and urge that further investigations be made in this field.

A STUDY OF PEAT-BOG FLORAS

In the last Report of the Iowa Geological Survey Professor L. H. Pammel discusses the peat flora found in the swamps and marshes of Iowa. For the bog formations he follows C. A. Davis's monograph. These bogs are not of the *Sphagnum* type usually associated with the term, but are listed by the author as follows: Quaking aspen bog, willow bog, grass and sedge marshes, rush marshes, moss bogs. The bog floras of Iowa, Wisconsin, southern Michigan and the Dismal Swamp Virginia are compared from a list of three hundred or more plants, showing strikingly the differences in their constitution.

The following observations may be noted. *Sphagnum, Larix laricina, Thuya occidentalis* and *Picea mariana* are not found in the state. Heaths are absent from the swamp flora. Of the fifteen plants listed by Transeau as characteristic of the bogs of northern America only five are found in the bogs of Iowa. Certain plants common to the peat bogs of regions farther north are not in the bogs of Iowa but are found in the colder and less fertile locations. *Carex filiformis* is the best peat former in the state.

The author discusses the important contributions to the subject, and gives a bibliography.

THE PRINCIPLE OF HOMOEOSIS

About a year ago Professor R. G. Leavitt published (*Bot. Gaz.*, January, 1909) a paper entitled "A Vegetative Mutant and the Principle of Homoeosis in Plants," which has not received the attention it deserves at the hands of botanists, no doubt partly due to the fact that it was not fully understood, and also that botanists, as a rule, are not greatly interested in underlying principles. They are so busy with the collection of solid facts of one kind and another that such "vague and insubstantial" things as principles have little attraction for them. This may account for the assertion made by a well-known professor of philosophy in a gathering of botanists a few years ago, namely, that "while botany has had many eminent men, it has been singularly unproductive in giving to the world any conspicuous general principles." Be this as it may, the fact remains that scant attention has been given to the paper here referred to, and to the principle which it sets forth.

Beginning with some familiar cases of leaf abscission, and of the decompounding of

other leaves, the author takes up the discussion of these and numerous related phenomena. He sees in them a trans-location of characters, that is, the transfer of characters from one structure to other structures, which latter may be further along in the ontogenetic line, or not so far along, or may belong to the alternative generation, or may be morphologically non-equivalent to the structures from which the transferred characters are borrowed. This transposition of characters he terms homoeosis, and in a paper of nearly forty pages illustrates and expands the principle with much force, and with convincing logic. Having established to his own satisfaction, at least, the doctrine of homoeosis, he is prepared to deduce certain conclusions as follows: "The study of homoeosis must somewhat increase the caution with which we use deviations from the normal as aids to morphological interpretation," a statement to which we fancy there will be little objection by any one, and which, it is to be hoped, will be taken to heart by morphologists and descriptive botanists the world over. It becomes evident that "relationship" may have a very different meaning when once we are aware of the facts of homoeosis, such as these which Professor Leavitt has so forcefully brought out in this paper. This service alone to morphology should justify the doctrine of homoeosis. His second conclusion that homoeosis has played some part in the evolution of plants will meet with little opposition. Lastly the author holds that the idea of homoeosis unites for descriptive purposes a great number of facts of ontogenesis which possess a considerable prospective value in connection with the effort to reach a correct mechanical interpretation of development.

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PALEOGEOGRAPHY OF NORTH AMERICA[1]

FEW articles of greater general interest have appeared in the *Bulletin of the Geological Society* in recent years than this. The paper may be divided into two parts—(*a*) an introductory portion dealing with methods, criteria and principles of paleogeography, and (*b*) the sequence of events in North America.

The author emphasizes the paleontologic method as of first importance. The distribution of seas is to be inferred from the distribution of faunas. The faunas are kept apart by barriers, of which the most important are land barriers. The local effect of currents in which there are differences of salinity or temperature is recognized, but the author thinks this can not be appealed to as an explanation of most faunal differences of the past. The physiographic testimony furnished by the sediments themselves is recognized as having a modicum of value, which in some kinds of deposits rises to first importance; but in general the usefulness of such data is not regarded as large. The important diastrophic events of geologic history are used to divide the course of time into eras and periods, and it is also pointed out that minor oscillations are often responsible for individual formations.

Following the views of Suess, Willis and others, Schuchert regards the continent as a mosaic of positive and negative elements; that is to say, regions which have shown a tendency to stand out of water as against regions which have been subject to repeated submergences. The location and general outline of these elements as conceived by the author are represented on two maps.

The commendable caution of Suess is followed in speaking of geographic changes not as uplifts and subsidences, but as "positive and negative displacements of the strand line," or as emergences and transgressions. The emergences are ascribed to periodic subsidence of the ocean bottom, causing the epicontinental seas to be drawn off into the ocean basins. The transgressions, or advances, of the sea, are thought to be due to one or more of several causes: (*a*) the attraction of the sea by bold shore mountains, (*b*) the down warping of the continent into geosynclines, thus forming long trough-like seas, (*c*) the displacement of the sea level by the filling up

[1] Charles Schuchert, *Bull. Geol. Soc. Am.*, Vol. XX., pp. 427–606, Pls. 46–101, 1910.

of the sea bottom as a necessary complement of erosion, and (*d*) the settling back of the continents in relaxation after periods of folding.

Following this discussion of principles the author gives a list of the chief strand line displacements with interesting although avowedly crude estimates as to the percentage of the continental plateau submerged at each stage. A graphic presentation of the same conclusions is given in the form of curves on plate 101 at the end of the paper. Barrell contributes a theoretical inquiry as to the effect which radial shortening would have on the rate of the earth's rotation, and on the degree to which a given increase in that rate would cause a heaping of the oceanic waters in the equatorial regions during times of orogenic activity. He finds reason to think that there would be a bulging of nearly 100 feet for each mile of radial shortening, which would tend to draw down the waters in the polar and temperate regions, to keep it stationary in latitude 35° and to cause a rise of the sea level in the tropics.

The second and much larger part of the paper contains a systematic account of the distribution and migrations of faunas, the geographic changes, and in some measure the nature of the climate and topography during the periods from the Cambrian to the Tertiary. This is illustrated by fifty maps showing the author's interpretation of the geography at each of many stages. To give a summary of this part would not be possible in a review, as it would almost necessitate a rehearsing of the original paper, which is itself much condensed. The most important general fact to be noted is the radical rearrangement of the geologic time table, which is given, in comparison with the current classification, as follows.

From this brief description it is plain that Mr. Schuchert's paper is one of first importance to the student of historical geology. It will be most highly valued as an up-to-date synopsis of the sequence of strata with their contained faunas from the base of the Paleozoic to the Tertiary period, and it will serve as a hand-book of information for many a stratigrapher whose opportunities and experience have necessarily been less extensive than the author's.

THE NEW GEOLOGIC TIME TABLE

Old Classification.		*New Classification.*	
Paleozoic	Cambrian	Georgic	Paleozoic.
		Acadic	
		Ozarkic or Cambric	
	Ordovician or Lower Silurian	Canadic	
		Ordovicic	
		Cincinnatic	
	Siluric	Siluric	Neopaleozoic.
	Devonic	Devonic	
	Mississippian or Sub-Carboniferous	Mississippic	
		Tennesseic	
	Pennsylvanic	Pennsylvanic	
	Permic	Permic	
Mesozoic	Triassic	Triassic-Jurassic	Mesozoic.
	Jurassic.		
	Cretaceous	Comanchic	
		Cretacic	
Tertiary or Cenozoic	Eocene	Eogenic	Neozoic.
	Oligocene		
	Miocene	Neogenic	
	Pliocene		
	Pleistocene		

Any one who has attempted the construction of paleogeographic maps knows the uncertainties with which the work is beset and the impossibility sometimes of knowing just where a particular shore line should be drawn. Under these circumstances it requires courage to put one's many doubtful views in the unchangeable record form of a map, and Mr. Schuchert is to be commended for what he has done in this way and for his interesting table of strand line displacements mentioned above. The imperfection of these is distinctly recognized in the author's introductory remarks and the aid of other students of the subject is solicited by him in making the maps agree with the progress of future discoveries. Doubtless many readers of the paper will, like the reviewer, be disposed to take issue with Mr. Schuchert on many matters of detail, but these are hardly within the province of a review.

The radical changes in the geologic time scale will probably arouse more differences of opinion than any other single feature of the article. It may be asked first whether each of

these changes is justified, and in the second place, whether they are likely to be accepted. Like other innovations, these will have to be tried out by the test of time and usage. It may be suggested in this connection that, if the Cambrian and Ordovician are to be bracketed as an era, the Pennsylvanian and Permian should also be set off by themselves for reasons which are well brought out by Mr. Schuchert's own discussion of these periods. To the reviewer it appears even more just that the Mesozoic era should be divided into two, the line of separation being marked by the intense and widespread Sierran disturbance. To be consistent in having periods based on diastrophic movements, the author should also combine the late Devonian with the Mississippian as one period,—a procedure which is sanctioned in effect on page 493, where it is said " . . . the diastrophism at the conclusion of the Devonic does not appear to have been marked in character. . . . In this instance the life record is thought to have greater value than the physical one in separating the Devonic from the Mississippic, but should the principle of diastrophism be the sole guide, then these two periods seemingly must be combined into one."

A study of the paper brings out the fact that the author has worked largely from the point of view of the paleontologist, excluding in large measure the data of other sides of geology. Indeed, this may be inferred directly from the author's own paragraphs on methods. On page 525 it is remarked that "these maps . . . are still inadequate, as far as presenting a final . . . geographic distribution of the various faunas is concerned." In other words the maps are really faunal maps rather than strictly geographic. That is to say, they show the distribution of fossils rather than of land and sea. Perhaps the author will contend that these are one and the same, but it is quite certain that others will dissent from this view and with much to be said on their side. In the reviewer's judgment, valuable information can be drawn from certain sources of which Mr. Schuchert appears to have availed himself only in small measure, namely, the character and changes in the structure and composition of the sediments and the relations of conformity and unconformity between them. For example, the author excludes the interior sea from the Utah-Montana region at various times in the Paleozoic era, because the necessary faunas have not been found; in the face, however, of the fact that in many places an unbroken sequence of marine deposits has been found ranging from middle Cambrian to Mississippian. Many stratigraphers will not agree that the failure to find a fauna in a given section proves the existence of a "break" or "stratigraphic hiatus," much less a "disconformity." If the section is completely exposed and *if there is no physical evidence of an unconformity* it would seem that the burden of proof rests upon any one who doubts that sedimentation was continuous during the periods in question, whether or not the faunas are present.

A reading of the paper gives the impression that the author recognizes only two important factors which cause differences in faunas, *i. e.*, time and geographic isolation; in other words, that the Cambrian and Ordovician faunas of New York are unlike because one is much later than the other, while the Cambrian faunas of New York and Utah are dissimilar because they lived in marine provinces between which migration was impossible. It is occasionally admitted in the paper, however, and is generally recognized by biologists, that a third factor is operative—the environmental or edaphic factor. That the author is aware of this is indicated by the statement on page 589: "The wide difference between the Cretacic of Mexico and that of the United States may be due in part to the decided limestone facies of the former region. . . ." But in most other instances where this factor might well come into play it seems to have been left out of consideration. Thus on page 550 it is remarked that the "wonderful Burlington crinoid fauna" is unknown "in the western sea." Since crinoids prefer certain environmental conditions and have by no means a uniform distribution on the modern

sea bottom, may not the edaphic factor help to explain the observed distribution, particularly since the dark Mississippian limestones of Utah and Montana are notably unlike the contemporaneous rocks of Iowa?

The lack of evidence on debatable points throughout the paper is a constant source of disappointment to the reader. Thus on page 454 it would be interesting to know what leads the author to suggest central California as the site of an inlet from the Pacific Ocean rather than some other part of the coast. The Paleozoic rocks are so highly metamorphosed or so deeply buried from Mexico to Alaska that only here and there (as in northern California and Oregon) are they clearly recognizable, and to the average geologist there seems to be no ground for choosing any particular spot for the purpose indicated. This deficiency is probably one which the author could not easily prevent. It is to be remembered that the subject is over-large to cover adequately in so brief a space. It may be hoped that Mr. Schuchert will soon find time to prepare a volume or volumes under the same heading, in which he will give the desired facts which support his views.

Two things will tend to detract from the confidence with which this important and otherwise impressive paper will be received by geologists in general. One is the nonchalant way in which questions of a complex nature are dismissed as if they were matters of established belief. For example, on page 490 one finds the implication that the origin of dolomite is a matter of common knowledge whereas it is still an unsolved riddle to keen students of the subject. Again on page 447 is the statement, "Oolites are formed in the littoral region of seas between tides. . . ." This may explain some oolites, but several other explanations have been offered and it can not be truthfully said that the subject of the origin of oolites is yet understood.

The second and more serious defect is the assertive and dogmatic form in which many a debatable matter is presented. Examples of this are abundant throughout the paper, but the following will illustrate: (page 453) "Its syncline (Rocky Mountain sea) was due to thrusting of the Pacific mass. . . ." There is still much difference of opinion among the best students of the subject as to just what causes the warping of land surfaces. (Page 459) "Throughout the Paleozoic the northern Atlantic waters were separated from the southern Atlantic by the great continent Gondwana, uniting Africa and South America across the medial region of the present Atlantic. It is, therefore, not correct to speak of the northern Atlantic until the present form of this ocean has been attained. . . ." The existence of the Afro-American land bridge, although indicated by a considerable mass of evidence, is denied by many whose opinions are worth considering. (Page 495) "There was no Cordilleran sea of this time" (late Mississippian). In this case the unequivocal assertion of the author can be as positively refuted since a rich Kaskaskia fauna was discovered last year in the Wasatch Mountains of Utah.

In conclusion, and after offering these criticisms, the reviewer desires to repeat that the paper is a storehouse of information and a large contribution to the subject—the fruit of many years of careful study by a man well qualified as a paleontologist and blessed with unusual opportunities in the way of facilities and associations. Even so soon after its appearance it is plain that the paper is stimulating interest in the relatively new and still plastic science of paleogeography, in which much must be accomplished before firm foundations can be reached.

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April 25, 1910

SPECIAL ARTICLES

WEBBER'S "BROWN FUNGUS" OF THE CITRUS WHITEFLY (ÆGERITA WEBBERI N. SP.)

H. J. WEBBER discovered this fungus in 1896 growing parasitically upon the citrus whitefly at Manatee, Fla. He described in detail the sterile form of the fungus.[1] This

[1] U. S. Dept. of Agr., Div. of Veg. Phys. and Path., Bul. 13, 27–30, 1897.

fungus when it first develops on the under side of an orange leaf in larvæ of the white-fly, forms a chocolate-brown (Saccardo's color chart, No. 10) stroma, which somewhat resembles the citrus red scale, *Chrysomphalus aonidum*. From the margins of this stroma there extend colorless thick-walled hyphae. This stage of the fungus is sterile, and in this condition it was described by Webber under the name of "Brown fungus."

In the later development of the fungus (usually in the summer or fall) it sends out long, straight, colorless hyphæ, which grow, not only over the under surface of the leaf, but around the edges and upon the upper surface. On the upper surface of the leaves, upon short lateral branches of these hyphæ, are borne aggregations of cells, which seem to be characteristic sporodochia of the genus-form *Ægerita*. These sporodochia are 60 to 90 microns in diameter, and are more or less spherical clusters of inflated oval cells, 12 to 18 microns in diameter. From near the place of attachment of the sporodochium there radiate 3 to 5 hypha-like appendages, 150 to 200 microns long by 6 to 8 microns wide, one to three septate. This entire aggregation of spherical cells and appendages remains in unison, and functions as a spore. When abundant, these sporodochia present to the eye the appearance of a reddish-brown dust over the upper surface of the leaves. If the lower side of a leaf bearing brown fungous stromata happens to be turned upward for some time, the sporodochia will develop abundantly there. These sporodochia were first noticed in the fall of 1905, accompanying the "brown fungus"; but only recently has the connection between the two been proved. Their supposed connection was touched upon in 1908.[3]

These sporodochia are curious and interesting. When once detached from the leaf, they blow about on smooth surfaces at the least motion of the air, but on alighting upon another leaf or fairly rough paper, they tend to hold fast to it.

[3] "Fungi Parasitic upon *Aleyrodes citri*," Univ. of Fla., Special Studies, No. 1, p. 36.

When germinated in hanging-drop cultures these sporodochia produce hyphæ identical with those of Webber's "brown fungus." When the sporodochia are placed upon the larvæ of *Aleyrodes citri*, typical stromata of the "brown fungus" arise. During the summer and fall of 1909, sporodochia were carefully picked off under a compound microscope. A camel's hair brush, moistened with water containing these sporodochia, was drawn over live whitefly larvæ. Nine days after, the first and second stage larvæ began to show the effects of fungous infection. In sixteen days, initial stages of the stromata were evident bursting through the edges of the larvæ. At a later date, the typical brown stromata were formed, and in three months *Ægerita* sporodochia were produced by the surface hyphæ on the upper sides of the leaves.

The economic importance of this fungus makes it desirable that it should have a scientific name. The form of the sporodochium most nearly resembles that of the provisional genus *Ægerita*. The fungus was referred to Dr. Roland Thaxter, of Harvard University, who kindly examined it, and confirmed the view that it might well be placed under the name of *Ægerita* until the perfect stage was found. It is therefore proposed to designate Webber's 'brown fungus" as *Ægerita webberi* n. sp. The form and appearance of the hyphæ suggest relationships to the Hypochnaceæ of the basidiomycetous fungi.

H. S. FAWCETT

A CORRECTED CLASSIFICATION OF THE EDENTATES

IN a recent paper[1] the writer was led, from a consideration of various anatomical characters, to the recognition of the Edentata as a *superorder* of mammals comprising four distinct *orders*, as follows:

SUPERORDER EDENTATA (Vicq d'Azyr).

Order 1. TÆNIODONTA Cope.
Order 2. XENARTHRA Gill.

[1] "A Suggested Classification of Edentates," State University of Oklahoma, Research Bulletin, No. 2, 1909.

Order 3. PHOLIDOTA Weber.
Order 4. TUBULIDENTATA Flower.

A further examination of the literature reveals the fact that the term PHOLIDOTA Weber (1904), comprising the *Manidæ*, is antedated by PHOLIDOTA Merrem ("TENTAMEN SYSTEMATIS AMPHIBIORUM," 1820), applied to the *Reptilia*. As SQUAMATA Huxley (1872), which also has been frequently used to designate the *Manidæ*, is itself antedated by SQUAMATA Oppel (1811), applied to an order or superorder (Osborn) of Reptilia, it seems necessary to adopt some other name for this group. I therefore propose that the order to which the Manidæ belong, be called the LEPIDOTA [Gr. λεπιδωτός, scaly].

Making this change and listing the families, our classification of the Edentates is as follows:

SUPERORDER EDENTATA Vicq d'Azyr.
- Order 1. TÆNIODONTA Cope.
  - Family *Conoryctidæ* Wortman.
  - Family *Stylinodontidæ* Marsh.
- Order 2. XENARTHRA Gill.
  - Suborder Pilosa Flower.
    - Family *Bradypodidæ* Bonaparte.
    - Family *Megalonychidæ* Zittel.
    - Family *Megatheriidæ* Owen.
    - Family *Myrmecophagidæ* Bonaparte.
    - Family *Orophodontidæ* Ameghino.
  - Suborder Loricata Flower.
    - Family *Dasypodidæ* Bonaparte.
    - Family *Glyptodontidæ* Burmeister.
- Order 3. LEPIDOTA Lane.
  - Family *Manidæ* Gray.
- Order 4. TUBULIDENTATA Huxley.
  - Family *Oryoteropodidæ* Bonaparte.

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STATE UNIVERSITY OF OKLAHOMA,
NORMAN, OKLAHOMA,
February 15, 1910

THE NORTH CAROLINA ACADEMY OF SCIENCE

THE ninth annual meeting of the North Carolina Academy of Science was held at Wake Forest College, Wake Forest, N. C., on April 29 and 30, 1910, with thirty-one members in attendance. The meeting of the executive committee, held on the afternoon of April 29, was followed by a general meeting for the reading and discussing of papers. At night in Wingate Memorial Hall, the academy was formally welcomed to Wake Forest College by President W. L. Poteat. President W. C. Coker, of the academy, then delivered the presidential address, "Science Teaching in the Schools and Colleges of North Carolina."

Because of their interest to the general public, the following papers were then given with lantern slide illustrations and diagrams: "Pellagra," a preliminary report, by Professor J. J. Wolfe, of Trinity College; "Halley's Comet," by Professor A. H. Patterson, of the University of North Carolina; "The Comet, What is It?" by Professor John F. Lanneau, of Wake Forest College.

On Saturday morning, April 30, the academy reconvened for the annual business meeting. The reports of the secretary-treasurer and of various committees were heard. Forty-six new members were received into the academy. These, together with the 43 former members, give a total membership of 89. The report of the treasurer showed the finances of the academy to be in a very flourishing condition. A large and representative committee was appointed to collect data and report to the next meeting of the academy a course of study in the sciences for the high schools of the state. It is the purpose of the academy to transmit this with its recommendation to the state superintendent of public instruction and to the North Carolina Teachers' Assembly.

The following officers were chosen for the ensuing year:

President—W. H. Pegram, Trinity College, Durham, N. C.

Vice-president—W. S. Rankin, State Board of Health, Raleigh, N. C.

Secretary-Treasurer—E. W. Gudger, State Normal College, Greensboro, N. C.

Executive Committee—F. L. Stevens, A. & M. College, W. Raleigh, N. C.; H. H. Brimley, State Museum, Raleigh, N. C.; H. V. Wilson, University of North Carolina, Chapel Hill, N. C.

In point of attendance, number of new members added, number of papers read, general interest as shown in the discussion of papers, this meeting excelled any since the founding of the academy.

The following papers were presented:

The Cause of Pellagra (a preliminary report): JAS. J. WOLFE, Trinity College, Durham, N. C.

Believing that pellagra must be an infectious disease, and that, because of its generalized nature, the organism was most likely to occur in the blood, the writer, last September, began a

study of some specimens of pellagrous blood with the hope of throwing some light on the etiology of this disease.

The usual smear preparation was made, stained with methylene blue and studied under a Zeiss apochromat. Bacteria were seen in considerable numbers in most cases—especially severe ones. Milder cases were more difficult and not as yet entirely convincing. These bacteria are polymorphic, but generally spherical, grouped often in doubles like a dumb-bell or in irregular clumps, sometimes in chains and usually between .5 and 1 μ in diameter.

A culture derived from damaged corn shows an organism quite similar in grouping, size, color reactions and polymorphism. This is now being tested with animals.

Peculiarities in Distribution of North Carolina Birds: FRANKLIN SHERMAN, Jr., Raleigh, N. C.

The main points brought out in this paper are as follows:

1. The song sparrow was long known to breed mainly if not exclusively on the very verge of the coast region. Records were given showing that it nests quite freely in the mountain region also. There is no evidence that it nests in any of the central sections of the state.

2. The towhee has been known to breed only in the eastern and western sections. Data were given showing that it also nests in the central section to some extent, though perhaps not so abundantly.

3. The barn swallow has been known to nest only on the coast. A record was given of its nesting at about 2,600 feet elevation in the mountains. It is not known in nesting season in the central part of the state.

4. The loggerhead shrike is mainly a winter visitor, going north to breed. Two or three breeding records are on file. Several new records are added, especially from the eastern section.

5. The robin has been known to breed only in the western half of the state. Data were given showing that in 1909, at least, it nested in a number of eastern localities. It may be extending its breeding range to the southward.

The tendency shown by certain birds (confirmed by some other animals and plants) to occur in the eastern and western extremes of the state is attributed to high humidity of the coast region which gives to the plants or animals the conditions of a more northern latitude. The western part of the state furnishes the same conditions by altitude.

The Comet: What is It? JOHN F. LANNEAU, Wake Forest College, Wake Forest, N. C.

The Resin of Pinus sabiniana: CHARLES H. HERTY and E. N. TILLETT, University of North Carolina, Chapel Hill, N. C. (Read by title.)

Medical Entomology: Z. P. METCALF, Department of Agriculture, Raleigh, N. C.

A short popular account of some of the more recent developments in the science of medical entomology, which was defined as that branch of entomology which treats of the relation of insects and insect-like animals in the transfer of diseases from man to man, man to animal and animal to animal. This relation was declared to be twofold: In the first case the insect is a necessary intermediate host and in the second case the insect is merely an incidental or accidental factor in the transfer of the disease. The work of the board of health of the city of Asheville, N. C., was cited as an example of applied medical entomology.

The Ammonifying of North Carolina Soils: F. L. STEVENS and W. A. WITHERS, assisted by P. L. GAINEY and F. W. SHERWOOD, North Carolina Agricultural Experiment Station, W. Raleigh, N. C.

Remarks on the Relation of our Birds to the Farm and Garden: C. S. BRIMLEY, Raleigh, N. C. (Read by F. Sherman, Jr.) Published in full in the current number of the *Journal of the Elisha Mitchell Scientific Society.*

Where to find Amebas: E. W. GUDGER, State Normal College, Greensboro, N. C.

The directions given in the books are very indefinite, as the writer found to his sorrow in his early biological days. Acting on a suggestion made by Dr. D. H. Tennent, now of Bryn Mawr College, he at that time successfully sought them in the yellowish-green diatom deposits on the bottom of stagnant ditches or of quiet pools in brooks. In seven years these have never failed to furnish abundant material. The writer's classes are supplied from a tiled drain at the foot of a bank less than one hundred yards from the laboratory. These amebas vary in size from quite small to those so large that they can not be seen in their entirety under the ordinary high objective.

The Origin of Thermal Waters, with Special Reference to Hot Springs, Ark.: COLLIER COBB, University of North Carolina, Chapel Hill, N. C.

Some Aids to Better Work in Science: C. W. Edwards, Trinity College, Durham, N. C. (Read by title.)

A new Hybrid Habenaria of North Carolina: J. G. Hall, North Carolina Agricultural Experiment Station, West Raleigh, N. C.

A hybrid *Habenaria* was reported from the neighborhood of Kinston, N. C. This natural hybrid seemed to be pretty well intermediate between the two supposed parents *H. ciliaris* and *H. blephariglottis*. Photographs of the flowers were shown and these presented some characters of the parents and the hybrid.

The Present Status of the Darwinian Hypothesis: W. L. Poteat, Wake Forest College, Wake Forest, N. C.

Some Experiments on Ionization by Impact: The Time Variation of a Current through a Gas Ionized by Radium: J. Blanchard, Trinity College, Durham, N. C.

The ionization vessel was a glass tube with parallel plate electrodes about five centimeters in diameter, both plates coated (though unequally) with a thin layer of a very impure salt of radium. With the plates about one centimeter apart, and the pressure about one millimeter, with a potential difference sufficient to produce considerable ionization by impact, it was found that the current decreased with the time the battery key remained closed, reaching its minimum value in about an hour. On opening the key the initial conductivity was almost totally regained in about the same time. Upon reversing the potential at the end of an hour the current was sometimes found to be greater than it was initially in this reverse direction, but also decreasing with the time as before.

The potential difference apparently causes an increased amount of ionization near the positive plate.

Further experiments are in progress.

Is the Fusarium which Causes Cowpea Wilt Genetically connected with Neocosmospora? B. B. Higgins, North Carolina Agricultural Experiment Station, West Raleigh, N. C.

In 1889 the wilt disease of cotton was studied by Professor Geo. F. Atkinson and its causal fungus named *Fusarium vasinfectum*. A few years later (1894–99) the wilt disease of cotton, watermelon and cowpea was studied by Erwin F. Smith. He found no specific differences between the fungi upon any of the three hosts. He found, however, upon some of the plants previously killed by the wilt fungus, an acigerous fungus which he considered the perfect stage of *Fusarium vasinfectum*. The fungus was therefore renamed by him *Neocosmospora vasinfecta*, and this conclusion has been accepted by subsequent writers. The evidence upon which this conclusion was based was very weak, however; and a recent study of the two forms by the writer—the results of which will at an early date be published in bulletin form—has caused the writer to reopen this question which was considered closed.

Some Experiments in the Propagation of the Diamond-back Terrapin: Henry D. Aller, Fisheries Laboratory, Beaufort, N. C. (Read by the secretary.)

This paper appears in full in the current number of the *Journal of the Elisha Mitchell Scientific Society*.

The Present Status of the Relativity Problem: C. W. Edwards, Trinity College, Durham, N. C. (Read by title.)

The Locus of a Moving Point when the Sum of its Distances from Two Fixed Points, their Difference, their Product or their Quotient is Constant: John F. Lanneau.

The loci determined by the first three conditions are the well-known ellipse, hyberbola and lemniscate.

Under the fourth condition: Take line through the fixed points F and F' as x-axis; the point O, midway between them, as origin; $2c$ for distance F to F'; K for the constant quotient when the moving point is on one side of the y-axis, and therefore $1/K$ the quotient when it has the corresponding position on the other side.

1. The equation of the locus is

$$x^2 + y^2 \mp 2c\frac{K^2+1}{K^2-1}x + c^2 = 0.$$

The locus, therefore, consists of two equal circles whose centers are on the x-axis beyond F and F', at equal distances from O.

2. A discussion of the equation shows:

If $K=1$, the circles are of infinite radius, and are tangent at O.

If K is either 0 or ∞, the circles reduce to the points F and F'.

If K has, in turn, any series of values between 1 and 0, or between 1 and ∞, the loci form a group of circles about F and a similar group about F'—the number of circles in each group limited only by the number of values given to K.

3. None of the circles of the F and F' groups pass through either of the fixed points F and F'.

Any circles drawn through F and F' are extraneous to the loci, but each such circle is orthogonal to every circle in the loci groups.

Notes on Fungi: F. L. STEVENS and J. G. HALL, North Carolina Agricultural Experiment Station, West Raleigh, N. C.

Three new species of *Claviceps* were described. Two of them are upon *Paspalum* and are thought to be the perfect stages of the fungus usually known as *Sclerotium Paspali* S. Germination of the sclerotium was described and the characters of the fungus were illustrated by photographs and specimens. The third species grows upon gama grass (*Tripsacum dactyloides* L.). Both sphacelia and ascosporic stages were exhibited. Technical descriptions were given under the names *Claviceps Paspali* (S.) n. comb.; *C. Rolfsii* n. sp., and *C. Tripsaci* n. sp. These will be published in full elsewhere soon.

Specimens of a *Cercospora* upon persimmon which was thought to be new were also shown.

Some Methods of Making Illustrations: Z. P. METCALF, Department of Agriculture, Raleigh, N. C.

A brief consideration of some of the more important methods of making illustrations considered from the standpoint of the biologist.

Precautions Necessary in Estimating Climates of Geological Time: COLLIER COBB, University of North Carolina, Chapel Hill, N. C.

The Jaws of the Spotted Sting Ray Aëtobatus narinari: E. W. GUDGER, State Normal College, Greensboro, N. C.

This ray and its jaws were described by George Marcgrave from a specimen from Brazilian waters in a book published in 1648. Unlike other pavement-toothed rays, this fish has only the central row of teeth, the lateral ones having entirely disappeared. Marcgrave correctly counted its fourteen I-shaped upper teeth, and its seventeen broad V-shaped lower ones. The lower jaw is narrower and longer than the upper and projects beyond the lips. With it and the snout the ray digs up the clams which constitute its chief food.

The paper was illustrated with photographs of the fish and with a pair of dried jaws.

The writer has in preparation for the U. S. Bureau of Fisheries, a paper on this ray, reviewing all the work ever done on it, and including his own observations and photographs.

The Cocoanut Crab: JOHN F. LANNEAU.

Called also the robber crab and the pouch crab. Shaped more like a lobster than a crab. Found on islands of the South Pacific. Weight usually five or six pounds, sometimes twenty. Feeds on fallen cocoanuts. Said to climb the trees. Is highly esteemed as food, especially the rich, fatty content of the pouch. Is found on our island of Guam. It and other singular forms of life on that pleasant little island would repay a biologist's investigation. His visit would likely be facilitated by our Secretary of War or Secretary of Navy.

A Double Flowering Dogwood: F. L. STEVENS and J. G. HALL, North Carolina Agricultural Experiment Station, West Raleigh, N. C.

A case of double flower of the common flowering dogwood (*Cornus florida* L.) due to the excessive development of the small bracts that subtend the individual flowers of the ordinary head was reported. There was as well the suppression of all the individual flowers except the central one, which appeared entirely normal.

A Note in the Development of the Gall-fly Diastrophus nebulosus O. S.: J. D. IVES, Wake Forest College, Wake Forest, N. C.

This paper is published in full in the current number of the *Journal of the Elisha Mitchell Scientific Society.*

Pecan Culture in North Carolina: W. N. HUTT, State Horticulturist, Raleigh, N. C.

E. W. GUDGER,
Secretary

SOCIETIES AND ACADEMIES

THE SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE

THE thirty-ninth meeting was held at the Sheffield Biological Laboratory, New Haven, Conn., on Wednesday, May 18, 1910, at 4:15 P.M., with President Morgan in the chair. An executive meeting was held.

New members elected: A. B. Eisenbrey, H. D. Senior, Edna Steinhardt, H. F. Swift.

Members present: Atkinson, Beebe, Davenport, Gies, Harrison, Henderson, Janeway, Lee, Levin, I., Lusk, MacCallum, Meltzer, Mendel, Morgan, Murlin, Norris, Pearce, Shaklee, Stewart, H. A., Wolf.

Scientific Program

"An Examination of Fröhlich's Theory of the Treppe," Frederic S. Lee and E. N. Harvey.

"An Attempt to Discover the Cause of the Specific Dynamic Action of Protein," Graham Lusk.

"Demonstration of a Modified Method of Estimating Pepsin," William C. Rose. (By invitation.)

"The Metabolism of the Purines in Man," Lafayette B. Mendel and John F. Lyman.

"A Demonstration of the Method of Phelps and Tillotson for Esterifying the Products of Protein Hydrolysis," T. B. Osborne and L. M. Liddle.

"The Distribution of the Blood in Shock," E. P. Lyon and J. L. Swarts.

"The Fundamental Conditions of Surgical Shock," Yandell Henderson.

"Observations on the Nature of the Antitrypsin of the Serum," R. Weil and L. Feldstein.

"On the Power of Reproduction without Conjugation in Paramecium," Lorande Loss Woodruff.

"Alleged Rhythm in Phototaxis Synchronous with Ocean Tides," Max Withrow Morse.

"Vaso-response in Dogs to Hydrophobia Rabbit Serum," J. P. Atkinson and C. B. Fitzpatrick.

"On the Precipitation of Diphtheria Antitoxin by Precipitins," J. P. Atkinson and Edwin J. Banzhaf.

"Further Observations on the Structure of Anastomosed Blood Vessels," C. C. Guthrie.

"Results of Engrafting Fetuses into Fowls," C. C. Guthrie.

"Factors Influencing the Survival of Engrafted Thyroid Tissues in Fowls," C. C. Guthrie.

"Modification of Tissue Oxidations *in vitro*," F. V. Guthrie. (By invitation.)

"The Development and Function of the Heart in Embryos without Nerves," Davenport Hooker. (By invitation.)

"A Demonstration of the Use of Krogh's Gas Tonometer," M. M. Scarborough. (By invitation.)

"An Experimental Study of the Resistance to Compression of the Arterial Wall," T. C. Janeway and E. A. Park.

"A Device for Control of Ether and Air or other Gases in Connection with Various Forms of Artificial Respiration," A. O. Shaklee.

"The Chromosomes in the Parthenogenetic and Sexual Eggs of Phylloxerans and Aphids," T. H. Morgan.

"Hybridization in a Mutating Period in Drosophila," T. H. Morgan.

"Inflammation in Tissues Isolated from Nervous Connections," W. G. MacCallum.

"Experimental Hypertrophy of the Heart," H. A. Stewart.

"Biological Significance of Sertoli Cells," F. M. Hanes. (By invitation.)

"A Study of Saliva in its Possible Relation to Dental Caries," Alfred P. Lothrop and William J. Gies.

"Studies on Experimental Arterial Lesions in the Dog," Isaac Levin and John H. Larkin.

"The Relation of the Thalamus to Respiration, Blood Pressure and Blood Supply of the Spleen," E. Sachs. (By invitation.)

"The Influence of Oils and Lecithin on Protein Metabolism," Lloyd H. Mills and John R. Murlin.

"Inheritance of Plumage Color in Poultry," Charles B. Davenport.

EUGENE L. OPIE,
Secretary

THE NEW YORK ACADEMY OF SCIENCES
SECTION OF BIOLOGY

A REGULAR meeting of this section was held at the American Museum of Natural History, April 11, 1910, Mr. Roy W. Miner presiding. The following papers were read:

Collecting Invertebrates in the Woods Hole Region: ROY W. MINER.

Mr. Miner gave an account of his collecting experiences during the summer of 1910 in the Woods Hole region. The methods and results of a dredging expedition were first outlined, and then the speaker gave an account of the habits of some of the more interesting and typical invertebrates found in the vicinity of Buzzard Bay and Vineyard Sound, dwelling especially on the Annulata. The address was illustrated with colored lantern slides of the living animals.

Osteology and Genetic Relations of the Menotyphlous Insectivores: W. K. GREGORY. (Read by title.)

W. K. GREGORY,
Secretary pro tem.

AT the regular meeting of this section held at the American Museum of Natural History, May 9, 1910, Professor Bashford Dean presiding, the following papers were read:

Notes on the Insectivore Genus Tupaia and its Allies: W. K. GREGORY.

In 1904 Dr. W. D. Mathew interpreted the characters of many Eocene mammals of various orders as pointing to a common stem form of arboreal habits and structure. The oriental insectivore *Tupaia*, and its little known Bornean ally *Ptilocercus lowii*, serve to illustrate these characters in still living forms. They nave a divergent but not yet opposable thumb and great

toe, their habits are chiefly arboreal and the diet insectivorous-frugivorous. *Tupaia* retains many skeletal features that were characteristic of Eocene unguiculates, *e. g.*, long humerus and femur, humerus with entepicondylar foramen, femur with third trochanter, radius and ulna and tibia and fibula separate, flexible carpus and tarsus, semiplantigrade, five-toed manus and pes with divergent digit 1, free centrale carpi, astragalus without trochlear keels and with a rounded head, vertebral formula C. 7, D. 13, L. 6 or 7, S. 3, Cd. 23–26—and many others. Other features distinctly foreshadow the primate type, *e. g.*, relatively large brain case, broad forehead, large, posteriorly closed orbits, and especially the structural details of the auditory bulla and ossicles, dentition and astragalus. In *Ptilocercus* the skull and dentition is even more distinctly lemuroid but the rest of the skeleton is unknown.

It is of course possible that these lemuroid characters are entirely due to convergent evolution, but the provisional conclusion is that the Tupaiidæ are descended from the Insectivore stock that gave rise to the primates. Attention was called to the resemblances between *Ptilocercus* and the lower jaw from the Bridger Eocene described by Mathew as *Entomolestes grangeri*. The only differences are such as frequently separate more generalized forms from their descendants.

Fourth Journey of Exploration in the South Seas: H. E. CRAMPTON.

The speaker gave a brief account of the new results obtained in the course of a journey of seven months' duration among the Society, Cook, New Zealand, Tongan, Samoan, Fiji and Hawaiian islands. The organisms forming the material of investigations were terrestrial snails of the genus *Partula*—a strictly Pacific group. The species differ when a comparison is made of forms occurring in neighboring but isolated valleys of one island, in different islands of the same group, and in different groups of islands. The uniform principle of distribution summarizing the observed facts is, that the degree of geographic proximity of any two comparable regions is correlated with the degree of biological differentiation of their species.

A description was given of two active volcanoes, namely, of Savaii in Samoa and Kilauea in Hawaii. Other older islands of volcanic nature were brought into relation with these examples, as later stages in the production of deeply-furrowed land masses like Tahiti, where conditions are such that isolated valley stations are found to be the homes of separate colonies of snails. Regarding the relation of such islands to other weathered peaks like Borabora, to coral atolls and to islands of uplifted coral limestone like many examples in the Cook and Tonga groups, the Darwin-Dana doctrine was contrasted with the views of Agassiz. It was pointed out that the phenomena of distribution in the case of species of *Partula* gave unquestioned support to the Darwin-Dana doctrine of a major process of subsidence, although secondary sporadic examples of the reverse process of uplift may be demonstrated at different points of the South Pacific Ocean.

L. HUSSAKOF, *Secretary*

AMERICAN MUSEUM OF NATURAL HISTORY

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 680th meeting was held on May 7, 1910, President Woodward in the chair. Three papers were read.

A Method of Precision for Computing Square Roots of Numbers: DR. R. S. WOODWARD, of the Carnegie Institution of Washington.

This method depends on the identity

$$ab = \tfrac{1}{4}(a+b)^2\{1-(a-b/a+b)^2\}.$$

Let N be any positive number and write $N = ab$, wherein a and b are any two numbers whose product is N. Write also for brevity $x = (a-b/a+b)^2$.

Then

$$\sqrt{N} = \sqrt{(ab)} = \tfrac{1}{2}(a+b)(1-x)^{\frac{1}{2}}$$
$$= \tfrac{1}{2}(a+b)(1-\tfrac{1}{2}x-\tfrac{1}{8}x^2-\cdots).$$

It is seen that if the numbers a and b are properly chosen the series in x will converge very rapidly. They may be so chosen in fact that a high order of precision will be attained from the expression

$$\tfrac{1}{2}(a+b)(1-\tfrac{1}{4}x).$$

It is seen also that the calculation by means of the latter formula will be simplified if a and b are so chosen that $(a-b)/(a+b)$ is the reciprocal of an integer n, or if $x^{-1}=n^2$. This applies especially in case N is one of the natural numbers 2, 3, 5, ... When n is an integer the following relations hold:

$$a^2 = N\cdot n + 1/n - 1, \qquad b^2 = N\cdot n - 1/n + 1.$$

When the approximation is limited to the first term in x, the exact value of the remainder, or error of the calculation, is

$$-\tfrac{1}{2}(a+b)\left\{1-\tfrac{1}{2}x-(1-x)^{\frac{1}{2}}\right\},$$

and this is the same as

$$-\tfrac{1}{2}(a+b)\left(\tfrac{1}{8}x^2+\tfrac{1}{16}x^3+\cdots\right).$$

The application of the process to the numbers 2, 3, 5 is illustrated by the following table of values:

N	a	b	$\frac{1}{2}(a+b)$	x^{-1}
2	$\frac{20}{14}$	$\frac{14}{10}$	$\frac{99}{70}$	$(99)^2$
3	$\frac{7}{4}$	$\frac{12}{7}$	$\frac{97}{56}$	$(97)^2$
5	$\frac{9}{4}$	$\frac{20}{9}$	$\frac{161}{72}$	$(161)^2$

The simplicity and precision of the calculations required are shown by the figures given below for the number 2.

$$\begin{aligned} 99/70 &= 1.4142857143, \\ -1/2 \cdot 1/70 \cdot 1/99 &= -0.0000721501, \\ \text{Sum} = \sqrt{2} &= 1.4142135642, \\ \text{Error} &= - \qquad\qquad 18. \end{aligned}$$

Halley's and other Comets: Professor ASAPH HALL, of the U. S. Naval Observatory.

The speaker gave some interesting points about Halley's comet, including the date of its reappearance, its physical appearance, its relative brightness and orbital elements. This comet has been surely identified back to the year 1066 and probably to a much earlier date. The supposed physical constitution of comets was discussed at some length. Among the other comets mentioned were Brook's, Swift's and Encke's. The orbits of most comets are parabolic, or nearly so. A number of planets have their own family of comets. Comet captures by planets and the perturbation effects of the sun and the planets were briefly discussed.

Is there an Emanation from a Magnetized Substance? L. A. BAUER, of the Carnegie Institution of Washington.

The purpose of the paper was mainly to direct attention to the fundamental assumptions which underlie our explanations of magnetic phenomena. The question was raised as to what evidences there may be for or against the hypothesis of a possible "emanation"—using that word in its most general sense, radiation, pulsation or emission—due to the presence of a magnetized substance so that the force exerted by the latter might, like electric force, be corpuscular in its nature. The corpuscles in magnetism might be atomic systems in which an electron is revolving about an inner nucleus consisting, for example, of a positive ion, such as assumed by Righi for the formation of his so-called "magnetic rays." Righi calls his atomic system an electron-positive ion, and Thomson, who independently of Righi had occasion to consider the possibility of similar systems, termed them "doublets." Since the system creates an atomic magnetic field whose axis passes through the center of rotation of the electron and perpendicular to the plane of rotation the speaker suggested calling such systems "magnetons." These magnetons, carrying a free magnetic charge, if given a translational movement along the magnetic axis, will possess all the properties ascribed to the lines of magnetic force—the translational movement giving the tension along the lines of force and the centripetal acceleration of the revolving electron supplying the cross pressure.

Some results obtained by the speaker in connection with his careful weighings, in a wholly non-magnetic balance, of magnetized and unmagnetized substances, led him to consider the hypothesis of a mechanical force being exerted on a magnet by the outside medium due to a possible emanation or pulsation of some kind from the magnet. Further experiments are to be made.

If the hypothesis as above set forth is correct we may look upon a magnetized substance as a source of "magneto-activity" just as a radioactive substance is of radioactivity.

(The abstracts of the first and third of the above mentioned papers are by their authors.)

R. L. FARIS,
Secretary

THE AMERICAN CHEMICAL SOCIETY
NORTHEASTERN SECTION

THE ninety-eighth regular meeting of the section was held at the Twentieth Century Club, Boston, on April 29. Professor Henry Carmichael presented a paper entitled "Electrolysis of Chlorides Theoretically Considered," in which he described the advantages of a partition of asbestos cloth impregnated with portland cement, as a means of separating the electrode products in the analysis of brine. Mr. Jasper Whiting, in a paper upon "The Electrolysis of Brine," described in detail his electrolytic cell which makes use of the formation of sodium amalgam but is not open to many disadvantages possessed by the "Castner process."

K. L. MARK,
Secretary

SCIENCE

FRIDAY, JUNE 17, 1910

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MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

EXPERIMENTS IN GEOGRAPHICAL DESCRIPTION[1]

THE PRESENT CONDITION OF OUR ASSOCIATION

THE exploration of unknown lands and seas has, to my regret, seldom been the subject of essays presented before our association. It would appear that most of those who are active or bold enough to make their way far from the beaten track do not care for the more thorough study of geography to which we are pledged; or perhaps that we, with our interest in the more scientific and analytical aspects of geography, have not been sufficiently cordial to those explorers who go far from home and bring back narratives in which personal adventure almost necessarily has a large place. Nevertheless, we have not been altogether wanting in this respect. We have heard in earlier meetings something of the desert basins of inner Asia, of the lofty plateaus of the Andes, and of the great territory of Alaska; and I trust that we shall again from time to time have reports on distant parts of the world, particularly when they can be presented with such technical geographical skill as characterized the papers just referred to. Some such papers are listed in our program for this meeting, but if I thus call especial attention to the recent studious travels of Messrs. Woodworth, Huntington and Martin, it would be unfitting not to add at least a few words on the extraordinary geographical achievements of the

[1] Presidential address at the meeting of the Association of American Geographers, held in Cambridge, Mass., December 30, 1909, modified and extended in certain parts.

year now closing; a year that has brought us the news of the most remarkable advances in polar exploration ever made. Although our own work is mostly performed in well-known lands, we must recognize and admire the brave strength of purpose, the persistence in the face of exhausting hardships, which enabled Peary to reach one pole and Shackleton so very nearly to reach the other.

The work of our members has naturally been limited for the most part to our own country. It was at first feared that it might also be limited too closely to the physiography of the lands, because so many of us had been more concerned with that division of geography than with any other; but if we have at any time deserved that reproach, the meeting last winter at Baltimore merited and indeed received altogether different comment; for Professor Penck, who was then our guest, described it as giving a well-distributed attention to various phases of our subject; and Dr. Gilbert, our president at that time, considered the meeting to be a thoroughly serious and scientific assembly. These two opinions are surely most encouraging; yet we still have work to do in the way of broadening our relations. We would willingly see oceanography and climatology more fully represented on the inorganic side of geography, and on the organic side there is pressing need of more attention to the geography of plants, animals and man than has yet been given. We therefore have abundant room for expansion, and I beg each and all of you to use all appropriate efforts to make our needs known in these several directions. As a practical step in this direction, I suggest that we invite representatives of allied subjects, such as history, economics and biology, to address us from time to time on their conception and use of geography.

We have, I believe, still the distinction of being the only geographical society in the world in which some definite geographical accomplishment is required for membership. I trust that such a qualification will be carefully maintained. We have probably the further distinction of being the smallest geographical society in the world; we are indeed so small that it is difficult and disappointing to believe that all the trained and productive geographers in North America are included in our list of some eighty names. Let me, therefore, commend the discreet nomination of new names to the council, always provided that the nominees have reached the stage of studious and original geographical production; and let me even more particularly advise that personal invitation be given to earnest younger students of geography to attend our meetings as guests of the association, in the hope that what they see and hear among us will encourage them to secure serious professional equipment and to reach active production in geographical science. In due time, they having become members, it will be their turn to maintain our simple organization and to foster its fuller development.

EXAMPLES OF UNSYSTEMATIC DESCRIPTION

The particular subject on which I wish to address you to-day concerns, as you might expect, the study of land forms, and more especially the manner in which land forms may be effectively described by mature observers, so that they may be appreciated by mature readers. Let me consider with you whether it is desirable and practicable to make at least some approach to systematic methods in describing the landscapes with which every geographer has to deal in the narrative of his travels, or in the account that he gives of particular areas in his regional studies. My own

answer to this question is decidedly in the affirmative, and I propose to illustrate at once the need and the value of some sort of systematic method by the rather invidious device of giving an example of unsystematic description, taken from the first geographical journal on which my hand happened to fall after the intention to cite such an example was formed. The following abstract, therefore, presents all the statements concerning the structure and form of a certain mountain range, in the order in which they are presented in the essay referred to; but distances, directions and other details are changed so that the source of the abstract can hardly be identified, and a considerable amount of general description that is aside from my purpose is omitted.

The mountain mass, entirely isolated and having a very remarkable geological constitution, is a high range, which rises abruptly at its northern end in the form of a great escarpment, surmounting the plain by some 3,000 or 4,000 feet; the range continues in an almost direct course to the south for about 40 miles. The summit is of very difficult access, the rocky wall being nearly vertical and mostly bare for the uppermost 1,500 feet. There is said to be no deep pass through the range. At an elevation of 2,000 or 3,000 feet there are grassy benches. On all sides the crests are very steep, with altitudes of from 4,500 to 6,000 feet; the culminating point rising to 6,300 feet. The crest is not continuous. Erosion has dissected the top of the mountain into a multitude of knobs and small plateaus. The entire range is formed of sandstones, inclined in general at an angle of 45°, and trending like the range from north to south. The sandstones rest on granite, which reaches an altitude of 1,900 feet at the village of Blank; while near River So-and-so the sandstones are seen at an altitude of 1,200 feet. On certain lower terraces, horizontal sandstones are deposited. The range has the appearance of constituting the eastern limb of an anticline, but it is difficult to explain in what way erosion has removed the sandstones of the western limb from the plain, since they form a heavy body in the range. Deep V-shaped valleys, parallel to one another, veritable torrent beds, are seen in large number on the eastern flank. After reaching the foot of the range, at an altitude of 1,000 feet, the torrents become quiet streams.

Part of this description is rather baffling. For example, what is the general form of the top of the mountain, in which erosion has produced a multitude of knobs and small plateaus? On reaching this statement, after having previously read that the summit is of difficult access, the upper rocky walls being nearly vertical and the crest very steep on all sides, one might make the provisional inference that the mass was of horizontal structure, like a lava-capped mesa; but this inference is not consistent with the earlier statement regarding the well-defined north-south trend of the range, and it is explicitly contradicted by reading, a little farther on, that the mountain is formed of inclined sandstones. One must feel rather vexed not to be told at once in which direction the sandstones dip; for until such information is given, the reader has to keep two pictures floating in his mind; one of an east-dipping monoclinal range, the other of a west-dipping monoclinal range. But he may throw away the second picture after reading a little farther and coming to the comparison of the range with the eastern limb of an anticline, of which the western limb is lost. This is the only indication given by the observer that the dip of the sandstones is to the east. The absence of the western limb of the postulated anticline tempts the reader to suppose that the range, instead of being part of an anticline, is really an east-tilted and dissected fault-block; even though the observer, after he has himself discredited the suggestion of anticlinal structure, says nothing about this manifest possibility. Theoretical discussion is therefore as fragmentary as the record of observation. In fine, the more carefully one reads the

article, the more one is impelled to say that certain important items are omitted; that such items as are mentioned are introduced in no apparent order; and that the method of treatment is uneven, arbitrary and accidental, being explanatory in one part and empirical in another.

By rearranging the facts presented, the reader may form a more systematic description. In the absence of explicit statement to the contrary, normal erosion is naturally assumed to have caused whatever changes have been produced during the development of the existing form from the initial form. The systematic description may then proceed as follows: The range, trending north and south, with altitudes of from 4,500 to 6,000 feet, is a monocline of heavy sandstones which dip eastward, and which are underlaid by granite along the western flank. The northern termination is a high cliff; the southern end is left undescribed. (Whether the initial form of the mass was a tilted block or not must be left undecided, because no sufficient account is given by the observer either of the constitution or of the form of the lower ground from which the range rises.) The crest is somewhat dissected but not deeply notched; the eastern flank is well dissected by consequent streams; the western flank is presumably more or less ravined by obsequent streams. On the whole, the stage of erosional development may be provisionally regarded as submature or mature.

It is tantalizing to read of the grassy benches at altitudes of 2,000 or 3,000 feet, and not to be told on which side of the range they occur, or how they are related to the structure of the mass; possibly they are granite benches on the western flank. One must discount the statement regarding the nearly vertical slope of the upper rocky walls, because vertical walls are altogether improbable if not impossible on the back slope, and are hardly possible even on the front slope of a monocline. Uncertainty must also remain regarding the piedmont terraces; perhaps they are remnants of a sandstone formation that once had a greater horizontal extension; but this can not be determined because of the vagueness of the phrase: "On certain lower terraces, horizontal sandstones are deposited." Inasmuch as erosion is explicitly mentioned as having affected the crest of the range and implicitly suggested as having ravined the eastern flank, it is unfortunate that its effects on the western escarpment and around the base of the range are passed over in silence. Uneven description of this kind is disappointing.

The point to be emphasized is that the description prepared by the observer would be much more easily apprehended by the reader if it had been orderly instead of disorderly, and thorough instead of fragmentary. Immediately following the introductory statement concerning the occurrence of a high and isolated range, trending north to south, one must wish to know its general structure; namely, that it is a monocline of heavy sandstones, dipping eastward, with a foundation of granite exposed in the western flank. After exploration is finished, the preparation of brief and explicit statement of this kind surely imposes no great burden on the observer; and as surely it gives great aid to the reader. Brief suggestion as to the initial form of the mass and as to the amount of change that it has suffered since its uplift would be helpful, because the reader could then, as it were, accompany the observer in his attempt to give an explanatory account of the present form. If erosion has gone so far that the initial form is altogether uncertain, an explicit

statement to that effect should be made. Normal erosion being understood to be the process engaged in carving the mass to its present form, various details regarding the dissection of the crest, the steepness of the upper slopes, and the ravining of the flanks, may be easily added in the latter part of the description in orderly fashion; and as easily apprehended. If the observer, on seeing the ravines in the eastern flank, hesitates to call them "consequent," because of the vague possibility of some other origin, he may immediately solve this difficulty by calling them "apparently consequent"; and the reader will at once catch his meaning, and also his uncertainty regarding it. If the observer hesitates to assert definitely that the mass was initially a tilted block, he may say it looks "as if" it had been uplifted as a tilted block, provided that that is really his best interpretation of the facts; and then the reader will find in this guarded statement the clue that he needs in order to gain the observer's point of view, to follow the rest of the description, and to form a good mental picture of the landscape. The essential principles here are, first, that the reader's mental picture can not be well formed, unless the observer describes what he has seen in terms that are susceptible of definite interpretation; and, second, that the mental picture can not be easily formed, unless the observer presents the results of his observations in a reasonable order.

Only after a definite description of the landscape has been presented, is it fitting to mention by name subordinate items, such as single villages and individual streams. It is altogether inappropriate to use unknown local names of villages and streams as a means of locating unknown structures and forms. This is a general principle that is too often overlooked. In the absence of all diagrams and maps in the article here considered, the reader gains nothing on being told, before the direction of monoclinal dip is stated, that the foundation granite outcrops near the village of Blank. He profits nothing on reading that the sandstones are seen on the banks of River So-and-so, the relation of the river to the range being unexplained, and even the direction of river flow being unmentioned. Such items may be useful hints to a second traveler on the ground, but they are distractingly irrelevant to a reader at a distance. On the other hand, after a general statement has been given, from which the reader may form a fairly definite conception of the structure and form of the range, it may well be added that at the western base, about so far from the well-defined northern end of the range, and near a large exposure of the foundation granite, lies the village of Blank; or that at the head of a certain obsequent ravine, located in such and such a way and drained by the headwaters of River So-and-so, the sandstones are reached at such and such an altitude.

THE NEED OF SYSTEMATIC METHODS

The article from which these extracts are taken affords a fair sample of the treatment accorded to land forms in most of the leading geographical journals of the world and in most of the books of travel, from which we must learn nearly all that we know about distant lands. If the article here abstracted departs from the average treatment of land forms, it is rather on the side of greater than of lesser fulness of statement; but here, as well as in the great majority of geographical books and essays, the method of treatment is really no method at all, as far as this division of our subject is concerned.

Such articles as those by Bowman on the Bolivian Andes[2] are altogether exceptional in the clearness and fulness of their explanatory treatment. There is very seldom any indication that explorers have had in mind any well-matured plan or standard, in view of which a mountain range or any other form that they come upon should be treated. Geographical essays seldom give us reason for thinking that their authors have had any thorough training in the analysis or the description of land forms; or for thinking that they are aware of the systematic association of parts that is so generally characteristic of the elements of a landscape, or of the reasonable origin of the associated parts by the action of ordinary processes. There is not even any clear indication that the observers are consciously experimenting with any definite method for the better presentation of the facts that they have seen. The random accounts of item after item are usually arranged in indiscriminate order, as if any accidental manner of presentation were all sufficient. This is truly one of the most disappointing features of the present status of geography. The very sources from which we ought to expect the best material—namely, original narratives in books of travel, and essays in the journals of the great geographical societies—give us records of the kind just cited, in which so important a part of our subject as land forms is, as a rule, treated in an utterly unscientific manner.

The prevailing absence of scientific method for the treatment of land forms may be, on the one hand, taken as a discouragement by those who believe that a systematic method would be helpful; for if disorderly, unscientific methods prevail at so late a time as the present, it must be, one may be tempted to say, because no other can be invented. But, on the other hand, the absence of method may be regarded as an encouragement, because it shows that the field is practically clear for the introduction of any method that will generally commend itself to practical geographers. The latter point of view is to be preferred. Let me, therefore, confidently urge upon all our members who are interested in this aspect of geographical progress to give a share of their time to the invention and development of a thorough-going method for the description of land forms, a method that may find general acceptance through being generally applicable; and to make experimental trial of the method for themselves, and explain it as well as exemplify it in their publications.

As an earnest of my conviction of the importance of this work, allow me to say that I have already made some experiments of this kind myself. You may remember that, two years ago, when we met at Chicago, I had the pleasure of conducting a conference in which the discussion centered chiefly on the possibility of developing and adopting a systematic method for the description of the lands, and in which I advocated the general use of what has been called the method of "structure, process and stage" for this purpose. It is my desire to-day to carry the subject of that conference somewhat farther; partly by reviewing what was then accomplished, partly by describing to you an experiment in the same direction that I made in Europe in the summer of 1908.

One of my objects at the Chicago conference was to bring forward various other systematic methods of treating land forms, besides the one with which I was experimenting myself; but no success was reached in this direction. Several members who

[2] *American Journal of Science*, XXVIII., 1909, 197–217, 375–402.

were present, and several absent members to whom I afterwards wrote, expressed themselves as unprepared to adopt the method of structure, process and stage in their work; but what impressed me more was that they did not propose any alternative method. Perhaps no sufficient opportunity was given for the presentation of such an alternative; but certainly none was forthcoming, either in discussion or in correspondence. Some members stated explicitly that they preferred to remain free from any limitations; and with a preference for full freedom I have the warmest sympathy. Indeed a wish to profit from the more general introduction of a systematic method does not, to my mind, unwisely interfere with such freedom. Improvements are always in order, and every one must of course feel free to introduce them. There are occasions, however, when some definite method of treatment has to be adopted for a time at least, as when one writes a geographical description of a tract of country, or when one presents the principles of geography to a class of students; and still more when one attempts to teach young geographers the art of geographical description. It was particularly with regard to such needs that I was interested to learn the opinions and the practise of my associates. Perhaps the title of the Chicago conference, namely, "Uniformity of Method in Geographical Investigation and Instruction," went too far; and as I am now minded, my object would be better expressed under such a title as "Experiments in the Systematic Description of Land Forms." It is especially that aspect of the subject which I wish to pursue further to-day.

A GEOGRAPHICAL EXCURSION IN ITALY

A good test of a method of description is found in its application to new fields. It was, therefore, with much interest that I looked forward two years ago to a journey to Italy in the summer of 1908, when it would be possible to revisit certain districts of which I had had passing glances in the spring of 1899, and to determine how far they could be described according to the method under experiment. But it occurred to me that an adequate and impartial experiment with a method could hardly be secured if the person who had developed it should also be the person who had to apply it. Others of different training ought to make the test. Hence a circular letter was sent to a number of correspondents at home and abroad, indicating a route and a plan of work, and inviting them or such of their advanced students as they could recommend to join me in Italy on June first. The success of this plan passed all my anticipations. We were favored by special permission from the Italian Ministry of War, secured through the kind offices of the American Embassy at Rome, to make field studies even near fortifications and along the frontier. We were allowed to purchase all sorts of maps, not usually on sale, at the Military Geographical Institute in Florence. We were cordially welcomed by scientific colleagues at various points. The members of the party all entered heartily into the spirit of the work proposed, and made a most harmonious even if a variegated troop. The numbers varied from four to forty or more in different parts of the route. The cosmopolitan character of the gathering was its greatest value; for under what conditions could one secure livelier incentive to geographical investigation or make a better test of a proposed method of work, than by visiting choice fields in the company of earnest students of different nationalities and different training, and discussing together the varied landscapes

that opened before us. Members who accompanied the party for a week or more included teachers from the universities of Paris, Lyons, Marburg, Genoa, Michigan, Cincinnati and North Carolina, Williams College and the Lycum of Oran (Algiers), as well as graduates or students from Berlin, Lille, Vienna, Bern and Cambridge (England); those who were with us for shorter periods represented the universities of Grenoble, Fribourg and Harvard, the military school of Fontainebleau and the state normal schools of Salem, Mass. and Cheney, Wash.

Our work began on June 1, 1908, at Ancona on the Adriatic (A, Fig. 1), where we studied a late mature coastal plain; and ended on July 18 at Le Puy en Velay in central France; and between times we saw the valley of the Lamone above Faenza (Fa), in the northeast flank of the Apennines, the basins of Florence (F) and of Val d'Arno within the Apennines; the

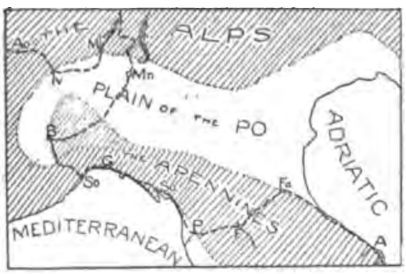


Fig. 1. Route of the Italian Excursion, 1908.

plain of Pisa (P); the beautiful coastal forms of the Riviera Levante between Spezia (Sa) and Genoa (G); the elbow of the Tanaro valley at Bra (B), where the river has been diverted from a former northward to its present eastward course; the lakes of Como (C), Lugano and Maggiore (M), and their associated Alpine valleys, where we discussed the problem of glacial erosion; the huge terminal moraines of Ivrea (Iv), and the glaciated valley of the Dora Baltea above them to Aosta (A); the pass of the Little St. Bernard, by which some of us crossed into France; the French Alps in the vicinity of Grenoble; and west of the Rhone the mountain belt of the Cévennes, formed by the dissection of the southeastern slope of the central plateau. It may well be imagined that we had much entertainment that was not strictly geographical; yet on the whole we held rather closely to the object of the excursion. One of the most amusing features of the journey was the necessity of using several languages in our daily intercourse; and here the European members of the party had great advantage over the Americans by their fluency in other tongues than their own. The determination taken by some of the American members to learn at least one foreign language before making another visit to Europe was not the least valuable lesson of our cooperative efforts.

THE METHOD OF STRUCTURE, PROCESS AND STAGE

As in the case of the Chicago conference, the most significant result of the Italian excursion for me was again the prevailing absence among the members of the party of any conscious and matured method for the description of land forms. That the method with which I had been experimenting was not familiar to my European companions was surely not due to any recondite elements in it, for there are none; all its elements are taken from the common experience of geologists and physical geographers. In so far as the method has any novelty, it is to be found in the systematic treatment of well-known elements; and even in this respect it is not so novel as some have seemed to suppose. Its fundamental principles are to be found, for example, in the third edition of

Sir Archibald Geikie's "Scenery of Scotland" (1901), where one may read:

The problem of the origin of the scenery of any part of the earth's surface must obviously include a consideration of the following questions: (1) the nature of the materials out of which the scenery has been produced; (2) the influence which subterranean movements have had on these materials, as, for instance, in their fracture, displacement, plication and metamorphism, and whether any evidence can be recovered as to the probable form which they assumed at the surface when they were first raised into land; (3) the nature and effect of the erosion which they have undergone since their upheaval; and (4) the geological periods within which the various processes have been at work, to the conjoint operation of which the origin of the scenery is to be ascribed (pp. 9, 10).

Here we have the very essence of what is implied under the terms "structure, process and stage"; and I fully agree that "obviously," as used in the first sentence, is precisely the word with which to introduce what follows. Yet, obvious as these considerations are as regards the origin of scenery, it is seldom that they are completely and systematically employed by geographers in the description of scenery. Their helpful use is furthered by their systematic treatment according to a definite method; and therefore method has here a practical value. Each member of my party knew well enough the various structures and processes involved in the production of natural landscapes, and could explain them item by item; nevertheless, hardly any one had consciously adopted a particular method for presenting the results of his observations regarding the natural combinations of the items, such as occurred in the landscapes that were repeatedly spread before us.

A generally favorable consideration was given to the method of structure, process and stage, during the excursion, but this must not be taken as counting altogether in its favor. A definite method naturally makes headway as against indefinite, unformulated methods; and moreover, as I was the leader and oldest member of the party, my views probably received a greater consideration than they would have gained if I had been a junior and a follower. Still, all allowances made, the excursion gave me great encouragement, and I resolved to persevere in carrying the development and the application of the method as far as possible; but always in the hopes of meeting other methods, developed by my colleagues; and always with the promise, to myself at least, to make careful trial of other methods as far as I could learn them.

THE DISSECTED COASTAL PLAIN NEAR ANCONA

Let me give a few examples of our work, beginning with two excursions in the neighborhood of Ancona, where sheets 117, 118, 124, 125 of the Grande Carta topografica del Regno d'Italia, 1:100,000, served as local guides. Here the earliest members of the party, a Frenchman, a German Swiss and an Austro-Galician, were present. The results may be briefly summarized as follows: The northeastern Apennines serve as the oldland to a dissected coastal plain, some 20 or 30 kilometers in breadth, composed of unconsolidated strata of clay and sand. The dissection has been carried to a stage of late maturity by prevailingly consequent streams with short insequent branches, the largest consequents being those which have been extended across the plain from the Apennine oldland to the sea. The oldland, although not sharply separated from the coastal plain, has a more deformed structure, a greater altitude, and a tendency to a longitudinal rather than to a transverse arrangement of its ridges. The relief of the district is moderate or small, with altitudes of 200

or 250 meters along its inner border, and of from 50 to 120 meters near the coast, where the sea has developed a fully mature line of cliffs which truncate all the seaboard hills in even alignment. The texture of dissection is rather coarse. In consequence of a slight and recent elevation, increasing from zero at the coast to 10 or 20 meters at the inland border of the district, the larger consequent streams have excavated mature flood plains below the remnant terraces of their earlier valley floors; and during about the same recent period the sea has withdrawn from the maturely aligned cliffs of its former attack and prograded a strand-plain from 200 to 300 meters in breadth, which at the river mouths is broadened in faintly convex deltas of about double this measure. Hence it seems as if the recently revived rivers had rapidly washed so much waste to the sea, that the waves could not immediately dispose of all of it, and therefore deposited a part of it along the shore, thus prograding the strand plain. These features are graphically summarized in Fig. 2, an imagined bird's-eye view, looking northwest.

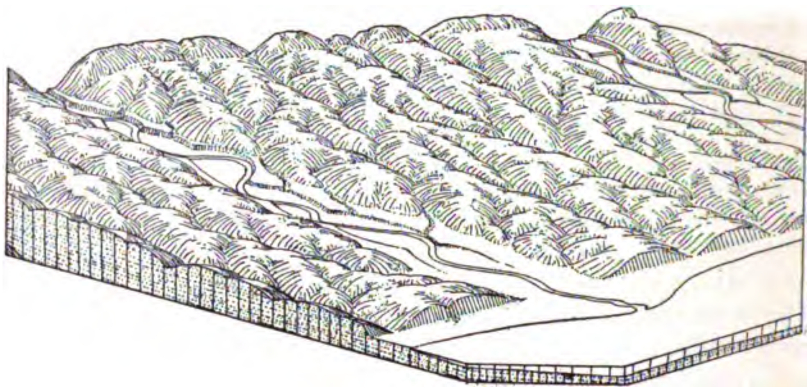


FIG. 2. Diagram of the Late Mature Coastal Plain, South of Ancona, Italy; looking West.

The essentials of the above description are, first, that it begins with a general statement from which the reader may immediately infer the total initial structure and form of the district concerned; second, that it proceeds, tacitly implying the action of normal and of marine processes of erosion, to state the stage that each of these processes has reached in the regular progress of its work; and third, that it adds in closing a brief account of the result of a slight interruption of the first cycle of erosion due to a slanting uplift of small amount, and with the cautionary words, *as if,* provisionally suggests the correlated origin of two new features, the terraced valley floors and the prograded strand plain, concerning which our brief excursions did not suffice to provide full proof.

Let us consider these points in more detail. From the term, coastal plain, which is given in the first sentence of the description, the initiated reader immediately understands a simple structural mass composed of stratified sediments, deposited on a sea floor when the region formerly stood lower than now, and when the sea had its shore on the flanks of the Apennine oldland; but now revealed as a land area, sloping gently seaward, in virtue of a broad uplift without significant deformation. Even if all this had been explicitly stated, instead of having been only implied in the term, coastal plain, the description

would not have been too geological, for every point of the structural statement bears helpfully on the appreciative understanding of the existing landscape, and hence on its proper description. Nothing is introduced simply for the sake of its geological interest, however great that may be; even the geological date of the strata concerned is left unmentioned, because this is geographically irrelevant.

It may be noted in passing that the terms coastal plain and coast plain have been used by some geographers to designate platforms of marine abrasion, now uplifted so as to form a littoral lowland. Geographical terminology is so little developed and systematized that no agreement as to the limitation of these and various other terms has yet been reached.

Although a marine coastal plain is in its earliest youth a smooth surface, gently inclining from the oldland to the sea, the first sentence of the description given above includes the significant word, dissected; and with this the reader must immediately pass from the conception of the initial stage of a smooth coastal plain to the later stage of a surface made uneven by the erosion of many valleys. The strata that form the plain are said to be unconsolidated, and this suffices to exclude all outcropping ledges from the present landscape, particularly as the dissection of the plain is said, in the second sentence, to have reached a late mature stage. All the hill slopes must therefore be conceived as cloaked with a creeping soil. The former shore line, marking the original inner border of the plain, must have lost whatever distinctness it may have had at the time of uplift; and it is indeed to-day hardly to be detected.

For similar reasons, all the streams must be conceived as having thoroughly well-graded courses, and all but the smallest valleys must be pictured as having flood plains of gentle fall. The general pattern of the streams and their valleys is sufficiently indicated by the words, prevailingly consequent and short insequent. These must be taken to mean that the larger streams flow almost directly to the sea in sub-parallel courses about at right angles to the general trend of the plain as a whole; while many small valley-heads branch in various directions from the trunk valleys. The hilly interfluves between the chief valleys must, in a late mature stage, be pictured as having lost something of their initial altitude, and hence, when looked over in the direction of the length of the plain, as no longer rising to a perfectly smooth and gently sloping skyline, but nevertheless as approximating to this form; while the spurs that branch from the axes of the interfluves must be pictured as generally pointing toward the sea and as descending by gentle, graceful and well-graded slopes into the open valleys. The texture of dissection being described as rather coarse, the hills and spurs must be conceived as having contour lines in flowing curves of rather large radius; and all close-set, sharp-cut ravines must be excluded.

At a late mature stage, the larger extended rivers must of course be pictured as having broad valley floors; and the sea must be imagined as having cut back or retrograded the front border of the plain, so that the sea-board hills are evenly truncated in a long succession of sea cliffs, all standing in accordant line over a well-developed beach. Deltas must be absent. The general picture thus sketched must then be slightly modified by terracing the main valleys and by widening or prograding the beach into a well-developed strandplain.

The technical terms here employed are

few; most of them are almost self-explanatory, but they are all highly significant. Consequent and insequent streams and valleys present elementary and fundamental conceptions in rational physiography. Retrogradation and progradation of a shore line by marine action correspond to degradation and aggradation of a valley floor by a stream; in both cases, the steady action of balanced forces is implied. Surely there can be no sufficient reason that the newly recognized ideas represented by these newly introduced terms should be neglected by modern geographers who employ, whenever they can, such innovations as motor cars, film cameras and daylight developers. Nor need there be any fear that the mere use of such technical terms as are here suggested will necessarily result in enforcing an unattractive, nonliterary style upon geographical descriptions. Attractiveness of style is a matter to be cultivated for and by itself; it is as well worth cultivating in geography as in history; but in neither subject should it involve a sacrifice of truth and efficiency to form and sound. The degree of technicality appropriate in a geographical description will depend largely on the condition of the readers for whom it is written. As the description presented above is intended for mature geographers, it does not seem to be either unduly technical or unattractively awkward.

It is assumed at the beginning of the description that Apennines and Adriatic are names that every mature geographical reader will know without explanation. No other local names are used in the general physiographic description. But now that the general features of the district have been presented, local names and all sorts of details may be conveniently added, and ontographic relations may be effectively introduced. For example, agricultural villages are found on the broader hills of the dissected interfluves, one of these being Loreto with its famous shrine, standing on a full-bodied spur-crest some four kilometers back from the coast; here pilgrims would appear to yield a larger revenue than farms. Fishing villages lie on the harborless strand plain, especially near the mouths of the larger valleys; in bad weather the boats are hauled up on the beach or towed into the little rivers. An important trunk railroad and a main wagon road follow the level strandplain for a long distance; branch railroads enter some of the larger valleys, and wagon roads turn up all of them; while roads of less importance enter certain smaller valleys and sidle in zigzags up the spurs to the farming villages on the interfluve hills, or follow the hill crests in passing from one upland village to another. It may be pointed out that Ancona does not belong to the coastal plain; it lies on the northern side of a cliffed promontory of altogether different constitution.

THE VALLEY OF THE LAMONE

Our second stop was at Faenza, where the valley of the Lamone was examined. It is the work of one of the many streams that extend in apparently consequent fashion from the northeastern flanks of the Apennines across a piedmont lower land, to the fluviatile plain of the Po, which here replaces the Adriatic sea. This late mature valley, enclosed by well-dissected uplands of moderate relief, is of particular interest in having an early mature valley of small depth eroded in its floor: that is, we have here the late mature work of an earlier cycle followed by the early mature work of a later cycle; the earlier cycle having been interrupted and the later one introduced by a gentle uplift. I was greatly impressed by the distinctness of

these combined features during a trip by rail from Faenza to Florence in 1899, and then resolved to examine them more at leisure at some later season. On going there in 1908 we were well rewarded by a delightful prospect over the valley from a favorable view point up on its western side, where our small party of four spent some profitable and memorable hours in the shade of a group of tall cypresses alongside of a little chapel, sketching, drawing maps and diagrams, and discussing our efforts at systematic description. Then we walked over some of the neighboring hills, and in the afternoon went by train a short distance farther up the valley for new observations. The results are summarized in Fig. 3, an imagined bird's-eye view, looking northwest.

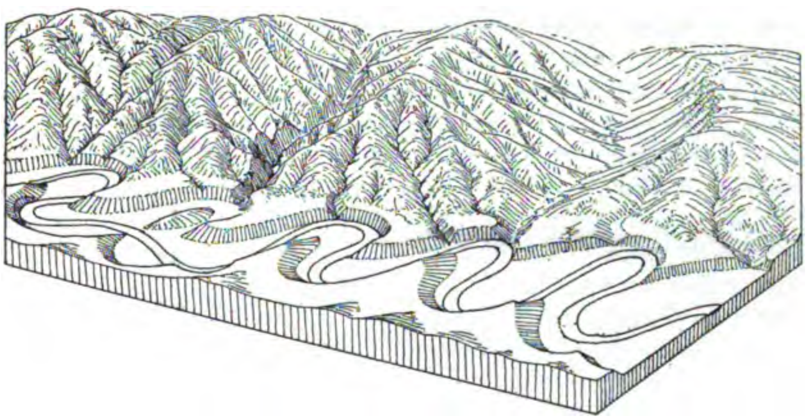


FIG. 3. Diagram of the Compound Valley of the Lamone, Italy; looking West.

We thus learned that the valley traverses two piedmont belts of unlike constitution; an inner belt of deformed and somewhat resistant strata, which trend in general parallel to the extension of the mountains in the background; and an outer belt of weak, bedded clays, dipping gently northeastward. The inner belt seemed to represent the well degraded border of the Apennine oldland, with respect to which the outer belt had been deposited; and the outer belt was apparently a continuation of the dissected coastal plain that we had seen by Ancona, here descending by straggling hills to the plain of the Po, instead of ending in an evenly retrograded line of sea cliffs. We noted first that in the inner belt of stronger strata the new, early mature valley, incised in the gravel-covered floor of the former, late mature valley, has a well-defined meandering course, with steep-walled amphitheaters in which the inclined strata of the district are well exposed, with sloping spurs sharply trimmed on their up-valley side, and with graceful flood-plain scrolls, systematically placed along the down-valley side of the trimmed spurs. The depth and breadth of the new valley both decrease up-stream, as if the work of the new cycle were less and less advanced as the mountains are entered. As might be expected, the lateral streams that here come down from the dissected uplands have as yet eroded only narrow, young, steep-walled gorges, with abundant outcrops, beneath the soil-covered slopes of the mature lateral valleys of the earlier cycle; but the lateral gorges are already worn deep enough to mouthe at grade in the main valley. We noted secondly that, in the outer belt of weaker strata, all the

features are farther advanced in erosional development, and that at the same time the depth of erosion decreases down-stream. The main valley of the first cycle was here widely opened; the main valley of the second cycle, originally a narrow, incised meandering valley, has now reached the stage of nearly consumed, blunted spurs, so that in this stretch the Lamone wanders freely on a flood plain of greater breadth than that of its meander belt. The valley sides of the lateral streams are here in large part already regraded with respect to the new depth that the valleys have gained; but in consequence of the faint northeastward dip of the weak clays, the higher part of the lateral valley sides are often incompletely graded on the northeastern or outcrop slope, and there exhibit a minute, bad-land dissection; while the southwestern or basset slope of the valley sides is smoothly sloping. As the hills decrease in height towards the plain of the Po, the height of the terrace remnants of the earlier valley floor over the newer valley also decreases; and the hills and the terraces vanish together at the border of the fluviatile plain. All this permits one to make a somewhat more definite statement regarding the uplift by which the first cycle of erosion was interrupted and the second introduced; namely, that the uplift seems to have been greater toward the mountains in the background than toward the plain in the foreground; hence, that it apparently involved a gentle northeastward tilting, such as had been inferred near Ancona. But let it be added at once that the geographer's interest in these inferences as to past uplifts of the Apennines does not spring from any concern on his part as to past events as such, but goes only so far as past events may aid him in the appreciative observation and the effective description of existing land forms.

A railroad and a main highway follow the western terrace remnant of the earlier valley floor; hence they have to cross the newly incised side-valleys on embankments and bridges. I believe a few small villages lie on the broad floor of the newer valley in the outer belt of weak clays; but in the inner belt of stronger structures, all the villages are on the terrace; the newer valley being too narrow for occupation. On the western terrace near the junction of the two belts lies the village of Brisighella; it was by the chapel just above this village that we spent our morning hours, sketching and writing; and I can strongly recommend this spot as the goal of a physiographic pilgrimage for all who choose to follow.

Thus I might go on describing the smooth-floored basin of Florence, in contrast to the maturely dissected basin of the Val d'Arno; the young lowland and its simple shoreline of elevation and progradation north of Leghorn, in contrast to the complicated mountainous shoreline of the Riviera Levante, with its interesting features due to slight and recent uplift towards Genoa, and corresponding depression towards Spezia; an account of this delightful district was presented to the research department of the Royal Geographical Society in March, 1909; it has since then been published in a paper on "The Systematic Description of Land Forms."[3] Much might be said of the maturely established elbow of capture of the Tanaro at Bra; of the superb exhibitions of glacial erosion in the overdeepened troughs of the Alpine valleys, whose terminal basins hold Lakes Como and Maggiore, and of the remarkable pair of glacial distributaries by which the irregular intermediate basin of Lake Lugano was excavated; and so on. It was

[3] *Geographical Journal*, September, 1909, 300–318.

much to our regret that while the excursion was in the district of the sub-Alpine lakes, where the party had reached nearly a dozen, no member could from conviction present the arguments of the anti-glacial erosionists. We did the best we could in their absence, but found it impossible to explain the over-steepened trough walls and the numerous hanging lateral valleys of most typical development without accepting a strong measure for glacial erosion. After crossing into France, two professors from the universities of Grenoble and Fribourg presented their views against wholesale glacial erosion during a visit to the strongly glaciated valley of the Romanche; but it seemed to most of us that their discussion was incomplete and unconvincing.

What with the variety of landscape that we studied and with the variety of training represented in our cosmopolitan party, it will, I think, be agreed that our discussions as to methods of describing land forms must have been profitably extended by the time the excursion closed in the volcanic district of central France. Without giving further account of our results, let me next present certain underlying principles, which appear to be of much importance in this connection.

DESCRIPTION IN TERMS OF TYPE FORMS

Whenever an observer attempts to tell what he has seen, so that a landscape or a region may be conceived by his readers, he must describe the observed forms in terms of certain similar forms previously known to him, and hopefully known also to those for whom he writes. It must always be in terms of something previously known that a verbal description is phrased. Hence the most accurate verbal description will be made by that observer who is equipped with the largest variety of previously known type forms. It is important to consider how a young geographer is to obtain such an equipment. The ideally perfect method would be for him to travel about the world and see with his own eyes a great variety of actual forms, from which he might gradually develop a complete series of type forms. Then all other forms could afterwards be described in terms of these types. But this method is manifestly impossible to general application. Some equipment of types may be secured by observation of actual forms; and this beginning may be significantly enlarged by the study of descriptions, pictures, models and maps of actual forms, as prepared by other observers.

The geographer who follows the empirical method stops here. The geographer who follows the explanatory method goes much farther. He extends and systematizes the equipment, thus far gained, by deducing many related forms; and thus fills his mind with a series of more or less ideal forms. It will then be chiefly in terms of the ideal types, largely developed by deduction, familiarized by diagrams, and confirmed or corrected by experience, that his explanatory descriptions of actual landscapes will be phrased. But whether the geographer follow the empirical or the rational method, it will be only in proportion to the completeness with which his series of ideal forms provides him with counterparts of actual forms, that his descriptions of actual landscapes can be true to nature. Only in proportion to the compactness of the terminology in which the ideal forms are verbally expressed, can the observer's descriptions be tersely stated. Only in proportion to the correspondence existing between the ideal forms as conceived and named by the observer and by his reader, will the reader be able to apprehend the observer's meaning.

Imagine, for a moment, that the observer had no mental conception corresponding to what is commonly understood by the word, hill. He would then have to fall back on geometrical terms, such as apex, slope, base, and so on, in order to give an account of a hill when he sees one; and his account would involve awkwardly long paraphrases. Or imagine that when the observer writes down the term, hill, the reader conceives the form that we usually mean by the term, hollow. The reader might mentally conceive a very definite landscape; but it would have little relation to the landscape that the observer had seen.

CONTRASTS OF EMPIRICAL AND EXPLANATORY METHODS

Let me contrast somewhat further the empirical and the rational use of type forms. In so far as ideal forms of types, with their corresponding terms, are learned partly from direct observation, partly from books and maps and pictures, they may be treated either empirically or rationally. If treated empirically, each type form, however learned by the student, must have been derived from some one's observational experience, without explanatory interpretation. If treated in the explanatory fashion, all the members of the series that are based on induction should be rationally or genetically accounted for as far as possible; while many other members, developed by deduction, will be perfectly understood, even though they are purely imaginary. Under the empirical method, diagrams are unsafe if they depart from the forms of nature, for their departures can hardly be reasonable under a method from which reason is excluded. In support of this strong statement, one need only turn to those fanciful not to say fantastic landscapes, which have so often defaced the pages of empirical text-books, and which bring together in the most absurd manner all sorts of incongruous land forms. Under the rational method, diagrams and especially block-diagrams, of which more will be said below, are of immense service; they present the graphic equivalent of deduced forms, whereby another person than the deducer may easily apprehend the intended meaning; and they serve at the same time as graphic definitions of a systematic terminology.

Furthermore, each member of the empirical series has to be learned without consideration of its origin and without explanation of its relation to other forms. Hence to the geographer who employs the empirical series, the corresponding actual forms in a landscape will seem to stand in purely arbitrary association with one another; the occurrence of one element of form can not be logically taken to indicate the associated occurrence of another element; the use of empirical types in the description of actual landscapes or regions requires that every part must be described for itself. On the other hand, all the types in an explanatory series, and particularly the deduced types, are learned in view of their origin by the action of some reasonable process on some specified structure through some limited period of time; and hence type-forms of this kind are necessarily considered in relation to their natural associates. The association may be regional, as in the case of the different parts of an ideal landscape produced by the imaginary action of process on structure to a given stage of development; or the association may be sequential, as in the case of a single element of form followed in imagination along its successive stages of erosional change, from the initial, through the sequential to the ultimate.

As a further contrast, all the many members of an extended empirical series of ideal types must be learned arbitrarily and separately, for no mnemonic aid from explanation attaches to any of them. All the members of an extended explanatory series may be divided into groups, so that the groups themselves shall have certain highly suggestive general relationships, and so that the members of each group shall be treated as systematically interdependent and easily remembered. The development of the explanatory series is immensely aided by the mental process of deduction, which may be carried on by a trained student anywhere and at any time at his convenience; but deduction has no significant place in the preparation of the empirical series, each member of which must originally be learned by some observer, traveling about in the actual world.

Having now pointed out the strong contrasts between these two kinds of type forms, in terms of which the descriptions of natural landscapes and regions must be made, let me hasten to state that no one to-day uses either kind in its purity. The most conservative empiricist will introduce some explanatory types and terms in connection with forms of which the origin is manifest, such as sand dunes, deltas, volcanoes and sea cliffs; while the most determined rationalist will not infrequently find certain actual features which he can not explain, and for which he can therefore establish no corresponding explanatory types. The difference between the empiricist and the rationalist is therefore not so much in their practise as in their intention. The empiricist introduces explanatory terms as it were by accident; he makes no conscious effort to substitute explanatory types for empirical types, and he has no definite intention of introducing explanation as the most effective means of description. The rationalist, on the other hand, consciously and intentionally strives to find out the origin of every form that he observes, and then tries to describe every observed form systematically in terms of deductively developed type forms. The conservative empiricist condemns the rash rationalist as using a dangerous method, in that it must often be unsafe to describe what one sees in terms of what one does not and can not see; and in that it is unwisely venturesome to introduce theoretical considerations, which are in many cases necessarily more or less doubtful, instead of holding to direct observation which is essentially safe. The sanguine rationalist criticizes the hesitating empiricist as using a blind method, in that it is short-sighted to describe only those things which can be seen with the outer eyes, and unreasonable to omit all those illuminating explanatory considerations, theoretical though they be, by which so much light is thrown on empirical facts, and by which the way is indicated to many facts which the empiricist overlooks.

My own preference for the explanatory method is so strong that the preceding paragraphs have probably done some injustice to the empirical method. Be this as it may, it seems to me a plain duty to use to the utmost every explanatory relation that we can discover, in so far as it aids us in describing existing landscapes. If the explanation seems assured, it may be used without qualification; if it appears somewhat venturesome, explicit notice may be given of its insecurity by introducing warning words; for example, "as if." The extraordinary advances made in the understanding of the evolution of land forms in the last half century, particularly those advances made by the government geological surveyors in the arid southwest-

ern part of the country, can not be neglected by the geographers of this new century. The only matter that is questionable is the manner in which the advances shall be practically applied in geographical investigation.

GEOLOGY, AS SUCH, TO BE AVOIDED IN GEOGRAPHICAL DESCRIPTIONS

The influence of geology upon geography has indeed been so great that it has come to be a common practise to introduce some statement of geological history, as if in explanation of the origin of land forms, so as to aid in their description; but if geological history is introduced in a more or less haphazard way, it often goes too far in taking the attention away from the geographical present and holding it too long on the irrelevant past; and it often does not go far enough in the way of emphasizing the origin of visible forms. The accidental geological explanation is moreover especially deficient in not developing a carefully extended series of deductive types, in terms of which existing forms may be presented. In some way or other such a series of types certainly ought to be developed and carried in the mind as an indispensable equipment for outdoor observation and description. The way that has been most convenient, effective and helpful in my experience is the one embodied in the method to which I have given the name "structure, process and stage," and of which some illustration has been afforded by the examples presented above from my Italian excursion.

THE SCALE OF VERBAL DESCRIPTION

There are certain supplementary considerations regarding the description of land forms to which brief attention may be given. The first concerns what may be called the scale of verbal description, and corresponds to what we familiarly understand by the scale of a map. The well-trained cartographer has had conscious practise in reducing large-scale maps to small scale, and knows that in so doing he must intelligently and critically select the major features for retention and the minor features for omission; he knows also that a really good small-scale map can be made only by reducing it from a well-prepared map of larger scale. What I wish to point out here is that the principle of large and small scales may be applied not only to maps, but to verbal descriptions as well. The kind of maps here considered are not those sketch maps of hasty route surveys, in which large spaces are necessarily left blanks; these would correspond to the verbal reports of hurried excursions in which the writer is well aware that his records are deficient in many respects. It is here a question of more thorough work; that is, of maps for which all necessary surveys have been made, and of descriptions for which all necessary studies have been completed. Then, just as a cartographer must intelligently select certain features to be retained in reducing a large-scale map to a smaller scale, so a geographer, who has already gained sufficient information about a district to complete an elaborate or large-scale description of it, must critically select the major features for retention and the minor features for omission, in compressing his account to the space of small-scale presentation.

In view of this principle, the geographer who wishes to make a well-considered, brief statement concerning a district or region must first learn a good deal more about it than can be contained in a little space. He must then intelligently and critically select the major features for retention and the minor features for omission. He must

furthermore carefully study the capacity and the limitations of verbal description, and thus come to perceive that his task in setting forth the features of a district in words is altogether different from that of the cartographer in setting forth the facts graphically. Cartographic representation permits, and indeed requires, the indication of every element of form that is reached by its scale, and gives to each element a definite location and dimension. Hence the cartographic representation of geographical features is very definite. The eye, when first looking over a map, glances from part to part, and apprehends chiefly those elements which by repeated occurrence give character to the district, and those which by reason of exceptional peculiarities stand forth from the others; afterwards, special parts of the map may be more closely examined. On the other hand, verbal description can hardly be understood unless the reader follows the order of presentation chosen by the writer. The description will be fatiguing if it attempts to state the location and size of every element of form; it is therefore best employed to state the generalized characteristics which the eye would perceive in looking over a map, thus giving first emphasis to prevailing features, and only secondary emphasis to less important special features. After the leading facts are thus presented, more elaborate description may well follow, with due attention to what may be called "local color."

Inasmuch as verbal presentation is necessarily linear, one item following another, emphasis is automatically given to those items which come first; subordinate rank is indicated for such items as are assigned a later place; but on a map there is no beginning or end; the whole surface is presented simultaneously, and the student may first take up any part he pleases. If any one wishes to learn minute details as to the length or direction of certain small streams, the location and altitude of hills, and so on, he can best find them on a map; but if he wants a well-phrased characterization of a district, he will be best helped by a verbal description, on a scale appropriate to the occasion. Hence the importance of giving conscious practise to the preparation of verbal descriptions of a given district or region on different scales; one might be ten lines long; another might fill a page; a third, a chapter; a fourth, a volume. A geographer who proposes to make himself proficient in his science ought to practise himself as thoroughly in writing descriptions on different verbal scales as in drawing maps on different graphic scales.

THE STYLE OF VERBAL DESCRIPTION

Maps differ in style as well as in scale. A wall map on a given scale is coarse-textured, so that certain leading features may be seen across a room. A map of the same region, and on the same scale, divided into sheets and bound in an atlas for library use, is crowded with minute details of fine texture. Verbal descriptions also may vary in style as well as in scale. For example: the first account of the dissected coastal plain on the Adriatic border of Italy may be regarded as of medium scale and of technical style; the several following paragraphs, in which the same ideas are presented in more general language, is on larger scale, so far as space is concerned, but as it is of popular rather than of technical style, it really adds no new facts, nothing but ease of apprehension to the smaller scale description; hence it may be compared to a wall map, in being offered to ready understanding. On the other hand, if the increased space had been given to a continuation of the technical descrip-

tion for the purpose of bringing in many details, the larger scale of description might then be compared to a larger scale of a map for library use, in which many small features are indicated. Hence style as well as scale requires consideration; and in acquiring the art of geographical description, conscious experiment and practise should be given to various styles as well as to various scales.

From all this it must appear clearly enough that the preparation of an effective verbal description, after all necessary field studies have been made, will require the careful consideration of several different points. The style to be adopted should be first determined according to whether the description shall be technical, for trained geographers; or popular, for intelligent, mature, non-technical readers; elementary, for young beginners. Second, consideration must be given to the scale or space permissible, according to the opportunity for publication and to the relation which the description bears to the rest of the volume in which it may be only a part. In view of the style and the scale as thus determined, the critical selection of certain items to be included and of others to be excluded may come next; and with this should go the careful determination of the order in which the included items shall be presented. It has already been shown that various items concerning location, dimension, attitude and direction of subordinate features had best be omitted from verbal descriptions, because they have their better place on a map; if included even in a large-scale verbal description of technical style, they will make it unreadable. It is chiefly the generalized treatment of dominant or of recurrent elements that deserve verbal statement, with subordinate place for the more significant exceptional features.

THE ORDER OF PRESENTATION

As to order of presentation, a whole essay might be written. I shall here emphasize only certain leading principles. The first is, to present the main idea in the first sentence; to give at once, at the very outset, a general block-statement for the district concerned. The reader will then most promptly apprehend its general nature, most easily follow the explanatory paragraphs as they are expanded, and most readily appreciate subordinate features, item by item, as they are introduced in orderly advance. The case is utterly different from that of a novel or a play, in which it is appropriate enough to conceal the plot till the end is approached; here the reader or listener enjoys being kept in the dark while the story is developed. But in a scientific essay, the reader ought, contrary to common practise, to be made aware of the end at the beginning, particularly if the explanatory method of description is employed; so that as the description advances, the leading explanatory ideas as stated in the first paragraph may be constantly confronted with the evidence that bears upon them, and so that the smaller features may be immediately placed in their proper position with respect to the general scheme. Narrative descriptions, in which items are presented in the order of encounter in the field, may be appropriate as a means of recording the work of hasty reconnoissances, but when the narrative method is employed in the presentation of more careful studies, the most that can be said of it is that, as far as scientific geography is concerned, it is a very easily acquired and unambitious method.

It has already been pointed out that the location of natural features should not be indicated by means of their relation to small artificial features, such as little villages, which must be unknown to most

readers; but, on the contrary, that small artificial features, such as little villages, ought to be located in relation to the previously described natural features, to which they stand in some reasonable relation. This principle should surely be carried out by those who believe that the location of artificial features exhibits some response to physiographic environment. Likewise, an individual hill or stream should not be first indicated by its name, which is the least natural thing about it, and which is unknown to the reader and therefore of no assistance to him in his reading. Such features should be introduced in general terms, by first describing the whole group of features to which they belong, and then singling out such members of the group for location and name as may be desired.

It is of prime importance to the writer to test his own description as he prepares it; to determine whether his manner of announcing the most general features is thoroughly effective; whether the order in which he introduces secondary and tertiary items is the most appropriate. Practise added to close scrutiny can alone develop proficiency. On the other hand, when a carefully prepared description reaches the reader, he must exercise a considerable degree of attention and skill, in order to apprehend the full significance of the writer's terse phrases; and he must use a skilful imagination in the process of visualizing the forms, large and small, as they are introduced by the writer. Here again, nothing but practise can produce proficiency; and all this suggests that the training of a would-be geographer ought to include conscious, well-planned exercises in all these processes of observing, generalizing, writing, reading and visualizing, just as surely as it should include exercises in surveying and map-drawing.

GRAPHIC AIDS IN GEOGRAPHICAL DESCRIPTION

The best geographical descriptions fall short of satisfying the reader if they are purely verbal; they ought to be supplemented by graphic devices wherever possible. A small scale map may be introduced to great advantage on an early page, in order to exhibit general locations; hence, well known as Italy may be, the places above mentioned in connection with my Italian excursion are probably identified more easily and more promptly than they would be otherwise, by means of the outline map, Fig. 1, prepared in an hour, here reduced to small scale, on which our route may be followed and on which the Ancona district and the valley of the Lamone above Faenza may be quickly found. A larger-scale map may, if available, be appropriately provided to accompany more detailed descriptions; a good purpose is served in this respect by the elaborate sheets of the Italian topographical map, 1:100,000, already mentioned, which clearly exhibit the mature dissection and the even truncation of the coastal plain, south of Ancona, and the strand plain by which the former sea cliffs are now separated from the shore line. Photographs and sketches serve to illuminate the text; but in recent years photographs have been rather recklessly used, particularly when they are printed in a very blurred condition on rough paper. Sketches are in many cases more serviceable, even though less accurate, than photographs, because they show what the observer wishes them to show. As a subordinate matter, let me add in this connection certain details that are often overlooked, if one may judge by many illustrations in scientific journals. First, the size of the page on which a figure is to be printed ought to be learned before the figure is drawn. Decision should then be made as to whether the figure shall occupy the

whole breadth of the page or only half-breadth; and to do this it is worth while to sketch the figure roughly on the scale that it will have in the text. When this is settled, the figure should be redrawn on double scale with really black ink in smooth firm lines, so that it may be effectively reduced in making a black and white "process" cut. If any lettering is included, let it be plain and unshaded. The number and title of the figure ought not to be drawn on it or below it; both can be set up in type, when the figure is printed in its proper place in the text, thus saving in time and gaining in appearance. These are trifles: but trifles ought to be properly attended to, and not neglected.

In addition to the various cartographic and pictorial aids thus far mentioned, let me call special attention to the device known as block diagrams, or bird's-eye views, such as Figs. 2 and 3, which may be designed so as to form useful supplements to descriptions that open with condensed block statements. Both tell the plot of the whole story at the beginning, and thus allow the reader to place all details where they belong, when they are met in later paragraphs. Just as block diagrams aid in giving graphic illustration to the members of series of deduced type forms, as has already been mentioned, so they aid in the understanding, the description of actual regions, because they serve so immediately to present the generalized type forms with which the observer compares the actual forms. When seen cornerwise, block diagrams have the advantage of presenting two structural sections, if desired, in immediate association with the surface forms that have been carved on the structural mass. When drawn in groups, they have the further advantage of compressing into a single view the several successive stages of development, which are verbally presented or implied in the statement of the text.

Diagrams of this kind are not and are not meant to be mere pictures of observed landscapes, for they must always be simplified by the judicious omission of much unessential detail, and greatly compressed by the omission of many repetitions of similar elements. They may indeed be rather fanciful, in being designs rather than copies of nature, as is the case with Figs. 2 and 3, above. They should be simply drawn so as not to demand too much time in preparation, yet they may still be vivid and effective in aiding the reader to grasp the meaning of the writer.

No one may be more conscious of the defects of diagrams than the one who has drawn them. In the imaginary view of the dissected coastal plain south of Ancona, here given in Fig. 2, the hill shading is very rough; all the slopes are drawn convex, and hence fail to show the graceful concave lower sweep down to the valley floors. The terraces in the main valleys and the narrow belt of oldland included in the background are too definite and distinct. The absence of all indications of forests and fields, of villages and roads, gives an impression of barrenness and vacancy that does no justice to the pleasing reality. Moreover, the dissected hills and the broad valleys of two consequent streams extended from the oldland do not correspond to any particular hills and valleys of the district concerned; they merely show the observer's generalized idea of the kinds of hills and valleys that characterize the district. Nevertheless, the drawing has a value in immediately presenting the essential features of a late maturely dissected plain, in which the streams and valleys are prevailing consequent, with some insequent branches; in which the hill sides are all reduced to gently graded slopes;

and in which the spurs in the foreground are all evenly truncated by the former sea cliff, in front of which the strand plain is now prograded.

Similarly, the invented sketch given in Fig. 3 shows only the kinds of features that were noted in the valley of the Lamone, and not the actual features themselves. The maturely dissected hills developed on the more resistant structures occupy the middle and left of the view; the incised meandering valley of the second cycle, is maturely opened beneath the floor of the broader, late mature valley of the first cycle; the sharp-cut side gorge through the hills of harder structure in the left-center contrasts with the wider side valley on the right, where the weaker clays of the dissected coastal plain replace the more resistant strata of the Apennine foothills; and in immediate association therewith is seen the broadened floor of the main stream after it passes from the more resistant into the less resistant structures. The diagram would surely be much more faithful, if it had been drawn from a hilltop on the near side of the valley instead of from the imagination of what such a hilltop view would be. Many of the lines would be smoother and steadier, if they had been drawn by a professional draftsman; but diagrams prepared by some one else than the observer are hardly more satisfactory than lectures prepared by an expert typewriter instead of by the lecturer himself.

Block diagrams are more immediately understood than maps are; they are vastly superior to mere profiles, which of all graphic devices are of least value to the geographer; for he is concerned with surfaces, not with lines; yet if profiles are wanted, they are found along the side of block diagrams, in their proper position with respect to the adjoining surface. For the purpose here indicated—that of giving an immediate introduction to the whole story—block diagrams are as much more serviceable than photographs, as photographs are more serviceable than block diagrams when it comes, later, to the presentation of details. One of the chief values of block diagrams remains to be mentioned; they can be drawn from any desired point of view, as in the case of Figs. 2 and 3, so as to show the features represented in the best possible relation to each other. Some ingenuity in the way of inventing and designing is here called for; and it is well expended if the final diagram is thereby drawn in the most effective manner.

An objection that is often raised against the use of block diagrams—that their preparation demands a knowledge of drawing—ought to have small weight among practical geographers, especially among the younger ones. To object to an effective kind of diagrams because their preparation demands a moderate skill in drawing, is like objecting to horseback riding during a geographical excursion in the West because it involves a little skill in the saddle; or to the use of original photographs as illustrations, because their preparation requires a little acquaintance with cameras and films; or to the consultation of European journals, because this calls for a moderate knowledge of foreign languages; or to map-making, because it depends on an elementary understanding of cartography; or to preparing a written report, because it involves a knowledge of composition. There must, of course, always be a great difference in the proficiency that different geographers will reach in these several associated arts; but any one who is in earnest in his work may soon acquire a profitable reading knowledge of a foreign language or two, or a sufficient comfort in horseback travel, or a simple proficiency in

photography, or a reasonable expertness in writing reports on various scales and in various styles, and also a helpful handiness in drawing diagrams. The only serious point here to be settled by a practical geographer is: are diagrams, foreign languages, photography, and riding, and so on, really helpful in the kind of work that he proposes to undertake; if they are, then he will as a matter of course set about acquiring some degree of skill in each and all of them.

OBJECTIONS TO THE METHOD OF STRUCTURE, PROCESS AND STAGE

Allow me briefly to consider some of the objections that have been urged against the method of structure, process and stage in the description of land forms. A German geographer has regarded that part of the method which involves the scheme of the cycle of erosion as too rigid, and has likened its use in the description of natural landscapes to the cramping of nature in a strait-jacket. Such a criticism only indicates the complete failure of the critic to apprehend the method; for it is essentially elastic and adaptable; much more so, I believe, than any other method of description that has been formulated.

Some other critics have regarded the method as too geological, because it requires the consideration of underground structures and of past processes. This it certainly does require; nevertheless, it introduces underground structures only so far as they aid in the appreciation of visible surface forms; and it introduces past processes only in so far as they aid in the explanatory description of actual surface features. In this respect, it is interesting to note that, judging by my experience in Germany a year ago (1908–09), the method of structure, process and stage is much less geological than the method of geographical description commonly employed by the younger geographers at the University of Berlin; for they habitually present past geological conditions and processes as such, and treat them as characteristic parts of geographical reports, even though the events thus brought in from the past bear in no direct or helpful way on the features of the present. Many interesting discussions were held on this point, always with the object of trying to emphasize the existing visible landscape as the object of a geographer's work, and hence with the wish to exclude every geological item, however interesting in itself, if it had no helpful bearing on the observable facts of to-day. For example, I questioned the value of the geological term, Triassic, in the account of a certain district in Hesse; my contention being that all a geographer's needs were satisfied when the composition, structure, thickness and attitude of the formation concerned were stated, without regard to its date; but German geographers seemed to be in favor of including the names of geological formations in geographical descriptions. The geologist of course wishes to know the date of origin, as well as the present structure and attitude of the formations that make up a district; but the geographer has little or no need of such historical information, although it is extremely important for him to know to what stage of erosion the district concerned has advanced in one or in several successive partial cycles. However, this is a subordinate matter.

An English geographer has expressed some doubt as to whether the method of structure, process and stage, which he recognizes to be of value for the description of small districts, will prove serviceable for the description of large regions. My own opinion on this point is that its value for large regions can only be deter-

mined by experiment, which I should like very much to see tried. In any case, we can gain no comprehension of large regions save by gathering and by generalizing observations of small visible landscapes. It is fair to expect that the better our understanding of detailed morphology, the better we can summarize general features. My own experience in describing the larger subdivisions of the United States and of Europe would encourage me to say that the explanatory method can be well used for the treatment of such areas; but I have made few systematic experiments with any other method of description.

Another geographer has expressed his fear that an explanatory method of description for land forms will prove dangerous in the hands of untrained students, and that young disciples may apply it in a way that will cause anxiety at first and horror afterwards. Horror is rather a strong word to use in this connection; but I can instance several examples that have caused me some anxiety, and others which have, I am sorry to admit, shocked me, to say the least. There is the case, for example, of a geographer who, inasmuch as he submitted an article to me for criticism, and accepted the criticisms that I made, may perhaps be regarded as a disciple to that extent; but surely he caused me some anxiety by stating in essence that "granitic districts are of rugged form." His evident error here was the failure to consider the erosional process and the time element, or stage of erosional development, in his partly explanatory treatment; for resistant as granite is, rugged as its forms may be in a youthful stage of normal erosion, and sharp as they may be in a mature stage of glacial erosion, granite must have subdued and rounded forms in late maturity; and like every other kind of rock, even the hardest granite must be worn down to low relief of very tame expression in old age, as abundant examples testify.

In another case a geographer who explicitly declared himself to be my disciple shocked me by the additional declaration that the scheme of the cycle of erosion, which is essentially involved in the method of structure, process and stage, must be inapplicable to districts in which frequent movements have taken place, because forsooth he thought that the scheme of the cycle could be used only where complete cycles ran their course! In both these cases and in various others of a similar kind, criticism ought not to be directed against the explanatory method of description, but against its wrong use. It is proverbial that "a little learning is a dangerous thing"; the proper guard against such danger is better found by decreasing the careless use of an explanatory method than by discouraging its careful development.

And finally, to close these comments with one that suggests a most peculiar attitude on the part of the critic, it has been objected that the method of structure, process and stage can not be applied until one knows all about the district that he is describing. In so far as the use of the method may require an observer to make a serious study of a district before he attempts to tell about it, the method is thereby recommended; but as a matter of actual experience, the explanatory method has proved useful even in the most hasty reconnoissance, because it aids so greatly in directing observation to significant points, which might as likely as not escape the attention of a blind empiricist.

The kind of criticism that the method of structure, process and stage really needs is, as has already been intimated, criticism based on the experimental and comparative use of various methods, each method being

first carefully thought out, and then all the methods being thoroughly and impartially applied to one and the same district. Experiment of this kind should of course be made by various observers of different trainings and preferences, and in different localities. Precisely this sort of experimental criticism was attempted during the Italian excursion of 1908, but under conditions, as already pointed out, that predisposed the jurors to a verdict in favor of a particular method. It would be a good thing for geographical progress if a larger experiment of the same kind could be made. I trust that our association may some day actively engage in such an enterprise.

W. M. Davis

Cambridge, Mass.

THE GRADUATE SCHOOL OF PRINCETON UNIVERSITY

Mr. W. C. Procter has renewed his gift of $500,000 for the Graduate College of Princeton University on the same conditions on which it was originally made, except that in view of the bequest of Mr. Wyman for the graduate school, which it is thought will amount to $3,000,000, the $500,000 to be collected to secure Mr. Procter's gift is to be used for the endowment of the preceptorial system in the college. After the meeting of the trustees on June 9, President Wilson gave out the following statement:

By the will of the late Isaac C. Wyman, of the class of 1848, a great bequest has been left to the university in terms which must be acceptable to every friend of Princeton and of the higher learning. Its amount is expected to be sufficient to enable us to form a great graduate faculty and equip graduate teaching upon as liberal a scale as we should desire.

William Cooper Procter, of the class of 1883, has, with admirable generosity, offered $500,000 to the university for the equipment and endowment of the Graduate College upon terms which will, I feel confident, commend themselves to every member of the board.

Mrs. Russell Sage has completed our great obligation to her by offering to extend the beautiful building she recently presented to the university and to add to it the great tower which is likely to be the chief architectural ornament of the university.

Mr. Procter makes it a condition of his gift that the buildings of the Graduate College shall be placed upon the golf links. Strongly as my own judgment would dictate a different choice of site, the expectations of immediate large development created by Mr. Wyman's bequest so alter the relative importance of the question of the position of the graduate college of residence that I feel it to be my duty no longer to oppose in tnat matter what I now know to be the judgment of a majority of colleagues in the board.

The recent discussion of the many questions connected with the development and administration of the graduate school has fortunately called forth from all parties expressions of opinion which show practical unanimity of judgment and purpose upon the questions upon which agreement was most important; inasmuch as it has developed common consent that the life of the Graduate College should be organized upon the simplest and most natural lines possible, and that the college should be of common use and benefit to all members of the graduate school.

I, therefore, very heartily congratulate the board upon a combination of circumstances which gives so bright a promise of a successful and harmonious development of the university along lines which may command our common enthusiasm.

SCIENTIFIC NOTES AND NEWS

Sir David Gill, K.C.B., F.R.S., has been appointed a knight of the Prussian Order of Merit.

Dr. Wilhelm Roux, professor of anatomy at Halle and eminent for his contributions to embryology, celebrated his sixtieth birthday on June 9, when a *Festschrift* in two volumes was presented to him.

Dr. E. A. Schaefer, professor of physiology in the University of Edinburgh, has received an honorary doctorate of medicine at the University of Berne, after lecturing at the University on "The Functions of the Pituitary Body."

The council of the Royal Society of Arts has elected Mr. Theodore Roosevelt a life member of the society under the terms of the

by-law which empowers it to elect annually not more than five persons who have distinguished themselves by the promotion of the society's objects.

NEW YORK UNIVERSITY has given its doctorate of laws to Dr. Henry Mitchell MacCracken, who retires from the chancellorship of the University.

PROFESSOR WILLIAM JAMES BEAL, of the Agricultural College of Michigan, has announced his intention of resigning the chair of botany at the end of the current school year, when he will complete forty years of continuous service.

DR. LOUIS H. DURING has resigned from the chair of dermatology in the University of Pennsylvania, after a service of forty years.

MR. H. C. BEYER, a student in the Graduate School of Harvard University, is now an ethnologist in the Bureau of Science at Manila.

DR. WOLFERSTAN THOMAS, assistant lecturer in the Liverpool School of Tropical Medicine, has been appointed director of the new laboratories supported by business firms at Manaos, in the state of Amazonas.

DR. JOHN M. MACFARLANE, professor of botany in the University of Pennsylvania and director of the botanic garden, has been granted a leave of absence for a year, which he proposes to utilize in study at several of the European botanical centers.

PROFESSOR HATSUNE NAKANO, who holds the chair of electrical engineering in the College of Engineering of the University of Tokyo, is at present visiting this country. He received degrees from Cornell University in 1888 and 1889.

PROFESSOR FREDERICK KEEBLE, dean of the faculty of science of University College, Reading; Dr. R. V. O. Hart-Synnot, director of the department of agriculture, with three other representatives of the college, have been visiting Canada and the United States, to examine our universities and colleges, and especially the agricultural departments.

PROFESSOR GEORGE R. MCDERMOTT, who holds the chair of naval engineering at Cornell University, having leave of absence for next year, will superintend the erection and equipment of ship yards and dry docks at Rio de Janeiro. He will sail in July for a tour of inspection of shipbuilding works in Europe, and after a similar examination of American ship yards, he will go to Brazil in October.

ON June 3 Professor A. Lawrence Rotch gave an illustrated lecture, "The Aerial Ocean and its Navigation," at the annual Convention of Pennsylvania Engineers in Harrisburg.

PROFESSOR THEOBALD SMITH, of Harvard University, delivered a lecture on "The Relation between Human and Bovine Tuberculosis," at the University of Illinois, on May 19.

THE following minute on the death of Dr. George Frederick Barker was adopted by the board of trustees of the University of Pennsylvania on June 7:

That the board has heard with deep regret of the death of George Frederick Barker, for twenty-eight active and for ten years emeritus professor of physics in the university. His lofty character won for him the respect and affectionate regard alike of officer, teacher and student, while the distinguished honors accorded him and his contributions to science added luster to the name of the university which he served so long and so faithfully.

MR. JOSEPH S. HARRIS, an officer of the U. S. Coast and Geodetic Survey from 1854 to 1864 and assistant astronomer of the northwestern boundary survey, later prominent as president of the Philadelphia and Reading Railway and other companies, a trustee of the University of Pennsylvania, has died at the age of seventy-four years.

MR. MICHAEL CARTEIGHE, for many years president of the Pharmaceutical Society of Great Britain, died on May 28, at the age of sixty-eight years.

DR. EMIL ZUCKERKANDL, professor of anatomy at the University of Vienna, died on May 28 at the age of sixty-one years.

THE death is announced of Dr. Paulin Trolard, professor of anatomy in the Algiers College of Medicine.

THE second session of the seventeenth International Congress of Americanists will be

held at Mexico City from September 8 to 14. The sessions will be held in the lecture hall of the National Museum in Mexico City. An organizing committee has been formed, the president of which is Señor Justo Sierra, secretary of public instruction and fine arts for the government of Mexico. The congress will deal with questions relating to the ethnology, archeology and history of the new world.

THE Rockefeller Institute for Medical Research, which has been supplying the anti-meningitis serum gratis for several years, has announced that it may discontinue, at any time after the expiration of the next six months, its preparation and distribution on a large scale. The consensus of medical opinion, based on the employment of the anti-meningitis serum in widely separated epidemics of meningitis, is to the effect that it is of undoubted value in reducing the mortality and preventing the severe consequences of the disease. The serum is without effect in any other form of meningitis than that caused by *Diplococcus intracellularis* (Weichselbaum) and its favorable action is most pronounced when it is applied early in the course of the disease. Hence it is desirable that state and municipal laboratories, engaged in the preparation of diphtheria antitoxin and allied products, should undertake the preparation of the serum and provide means for controlling the bacteriological diagnosis of meningitis, as they now do diphtheria and some other diseases. Unless the bacteriological diagnosis is controlled by competent authorities, the serum will, undoubtedly, be applied in some cases of meningitis due to causes which are not subject to its action, and not a few cases of epidemic meningitis will be deprived of the benefits of its use. The serum is administered by being injected into the spinal canal by means of lumbar puncture, which operation is also required to secure the fluid for the bacteriological diagnosis; and several separate injections of the serum are required in treating a given case. The effective employment of the serum is likely, therefore, to be restricted on account of the experience and skill required in its administration and the high cost of the commercial product, unless the preparation, distribution and, when necessary, administration are undertaken by state and municipal authorities.

THE department of plant pathology of the New York State College of Agriculture announces the establishment of two more industrial fellowships. This makes four industrial fellowships which have already been established for the investigation of the diseases of plants. The two new fellowships are: The Herman Frasch fellowship, established by the Union Sulphur Company of New York City. This provides for the investigation of the use of dry sulphur as a fungicide both to the plants and in the soil. This fellowship carries an annual appropriation of $3,000 a year for four years and provides for a senior and junior fellow. Mr. C. N. Jensen, formerly an assistant in the department of plant pathology, Cornell University, recently research fellow in the University of California, has been appointed to the position of senior fellow, and Mr. F. M. Blodgett, a senior in the department of plant pathology, Cornell University, has been appointed to the junior place. Two thousand dollars is to be used as salaries for the fellows and $1,000 a year for carrying on the work. The John Davey fellowship, established by the Davey Tree Expert Company, of Kent, Ohio, provides for the investigation of heart rots of trees. It carries with it an annual appropriation of $750 a year, of which $500 is used as salary for the fellow and $250 for carrying on the work. Mr. W. H. Rankin, who graduates from Wabash College this year, has been appointed to this fellowship.

THE following is a list of the men of science and others who will accompany Captain R. F. Scott upon his Antarctic expedition: Lieutenant E. R. G. R. Evans, R.N., second in command (western party); Dr. E. A. Wilson, chief of scientific staff, zoologist and artist (western party); Lieutenant V. L. A. Campbell, R.N., leader of the eastern party; Lieutenant H. L. L. Pennell, R.N., magnetic and meteorological work in Terra Nova; Lieutenant H. E. de P. Rennick, R.N. (western party); Lieutenant H. R. Bowers, Royal In-

dian Marine (Terra Nova); Engineer Lieutenant E. W. Riley, R.N., chief engineer (Terra Nova); Surgeon G. M. Levick, R.N., doctor, zoologist, etc. (eastern party); Surgeon E. L. Atkinson, R.N., doctor, bacteriologist, parasitologist; Mr. F. R. H. Drake, R.N., secretary (Terra Nova); Mr. C. H. Meares, charge of ponies and dogs (western party); Captain L. E. G. Oates, Inniskilling Dragoons, charge of ponies and dogs (western party); Dr. G. L. Simpson, physicist (western party); Mr. T. Griffith Taylor, geologist (? western party); Mr. E. W. Nelson, biologist (western party); Mr. D. G. Lillie, biologist (Terra Nova); Mr. A. Cherry Garrard, assistant zoologist (western party); Mr. H. G. Ponting, photographer (western party); Mr. B. C. Day, motor engineer (western party); Mr. W. G. Thomson, geologist (? western party); Mr. C. S. Wright, chemist (western party); Mr. T. Gran, assistant (western party).

UNIVERSITY AND EDUCATIONAL NEWS

THE Cleveland College of Physicians and Surgeons, which has been the medical department of Ohio Wesleyan University, will be consolidated with the medical department of Western Reserve University at the close of the present college year. The trustees of Western Reserve University have elected from the teaching staff of the medical department of Ohio Wesleyan University one member to the faculty and eighteen other members to the teaching staff. President Thwing has announced a gift by Mr. H. M. Hanna of $250,000 as an additional endowment fund for the medical department. This gift is the first quarter of an additional endowment of $1,000,000 which the university now purposes to secure.

MR. DAVID J. RANKEN, Jr., of St. Louis, founder of the David J. Ranken, Jr., School of Mechanical Trades, has deeded his fortune, estimated at more than $3,000,000, to the board of trustees of the school, to be used for its maintenance and enlargement.

MRS. RUSSELL SAGE has given a further sum of $148,000 to Princeton University for a tower and other improvements in connection with the dormitory she has given to the university.

DARTMOUTH COLLEGE receives an administration building by the gift of $50,000 from Mr. and Mrs. Lewis W. Parkhurst, of Winchester. It is a memorial to their son, Wilder Lewis Parkhurst, who died during his sophomore year at the college.

BY the will of Augustus L. Revere Harvard University receives $20,000 to found a Revere family memorial fund.

THE recent commencement exercises at the University of Alabama were marked by the formal acceptance by the university authorities of two new buildings, Comer Hall and Smith Hall. The dedicatory address for Comer Hall, the engineering building, was delivered by Mr. F. H. Crockard, first vice-president and general manager of the Tennessee Coal, Iron and Railroad Company, and that for Smith Hall, the geological-biological building, by Dr. J. A. Holmes, of the United States Geological Survey. These two buildings were erected at an approximate cost of $300,000. Smith Hall has been named in honor of Dr. Eugene A. Smith, who, as professor of geology and state geologist for many years, has rendered conspicuous service to the state. A native of Alabama, he was educated at the University of Alabama and at Heidelberg, receiving the doctor's degree at the latter in 1868. He has held his present position as professor of geology since 1871 and has been state geologist since 1873. Dr. Holmes, in his address dedicating Smith Hall, stated that, in having spent thirty-seven years continuously in the service of one state, Dr. Smith holds the record for length of service among living state geologists.

AT the Johns Hopkins University, Dr. H. S. Jennings, now professor of experimental zoology, has been appointed Henry Walters professor of zoology and director of the biological laboratory, in succession to the late Professor W. K. Brooks.

GABRIEL CAMPBELL, of Dartmouth College, will retire from the Stone professorship of

intellectual and moral philosophy. He has been an officer of the college since 1883. Dr. W. H. Sheldon has been transferred to the professorship made vacant by the retirement of Professor Campbell. Dr. Walter Van Dyke Bingham, now instructor in educational psychology in Teachers College, Columbia University, will join the Dartmouth faculty as an assistant professor of psychology.

AT the University of Missouri, Dr. O. D. Kellogg has been advanced from the rank of assistant professor to that of professor in mathematics.

DR. A. S. PEARSE has been promoted to the position of assistant professor of zoology at the University of Michigan.

AT Dartmouth College advances in grade from instructorships to assistant professorships have been voted to Charles E. Hawes, in anthropology, Leon Burr Richardson, in chemistry, and Dr. George Sellers Graham, in pathology.

H. S. JACKSON has been appointed professor of botany and plant pathology in the Oregon Agricultural College. Mr. Jackson has been, since August, 1909, research assistant in plant pathology at the Oregon Agricultural Experiment Station.

NELS C. NELSON and Thomas T. Waterman have been appointed instructors and assistant curators in anthropology at the University of California.

JACOB PARSONS SCHAEFFER, instructor in medical anatomy in the Ithaca division of the Medical College, has been promoted to an assistant professorship of medical anatomy.

MR. T. TOWNSEND SMITH, at present the holder of the Tyndall fellowship in physics in Harvard University, has been elected instructor in physics in the University of Kansas.

DISCUSSION AND CORRESPONDENCE

THE DEFINITION OF FORCE

THE discussion now going on in SCIENCE concerning the language to be used in explaining to students what force "is," must be of great interest to students. They will observe that there is good reason for the obscurity of their own vision. In the physics department, the student might finally learn to distinguish between the pound and the weight of a pound. In the engineering department he learns that a pound is a pound, and that the weight of a pound is also a pound. In the physics class he will be assured that the weight of a pound is different at different places. He will learn that the weight of the earth is equal to the weight of any other body which it attracts. The weight of the earth is equal to the weight of a pound, of a gram, of a ton or of the moon. In the engineering department he will be taught that the weight of the earth is equal to the weight of 1.35×10^{25} pounds. There was a time when the use of the phrase "conservation of forces" was excusable. We do not discredit Helmholtz for saying in 1854 that "nature as a whole possesses a store of force which can not in any way be either increased or diminished," or that "all force will finally pass into the form of heat." The words had not yet been given definite meanings, which would enable one to say what he had in mind.

The electrical engineers of our time have no difficulty in using modern notation. The mechanical engineers continue to use the good old definitions of Weisbach and Rankin. "Thus the British unit of force is the standard pound avoirdupois."

The notation which makes a proper distinction between the pound and the weight of a pound, or between mass and weight, or force, does not require us to say that force "is" a rate of change of momentum. Some of us prefer not to say this. In a lecture before the British Association at Glasgow in 1876, Tait made a rather strenuous attempt to enlighten Tyndall on the nature of force. In this lecture we are informed that "force is the rate of change of momentum." Again, it is stated that "unit force is thus that force, which, whatever be its source, produces unit momentum in unit time." In the discussion which followed this lecture a writer

in *Nature* suggested that there might be some difficulty in understanding how a certain rate of change of momentum could produce unit change of momentum per second. It was also suggested that, while we might measure the hunger of a man under various circumstances, by determining the number of pounds of beef he would consume, we should hardly be warranted in saying that hunger "is" a certain number of pounds of beef.

We shall probably continue to measure forces with spring balances. We shall always find that the force applied to a loaded wagon is greater than the change per second in its momentum. Tait's definition might give a zero value when the spring balance might show that the horse was behaving in a very creditable way.

Francis E. Nipher

SCIENTIFIC BOOKS

The Wonders of Animal Ingenuity. By H. Coupin, D.Sc., and John Lea, M.A., author of "The Romance of Bird Life." Philadelphia, J. B. Lippincott Company. 1910. Pp. 163.

This is an American reprint of an English book of popular natural history for young people, dealing with the "wonders" of the nest-building instinct in spiders, insects, fishes, birds and mammals. The facts are gathered largely from such authorities as Huber, Moggridge, Fabre and Brehm. They are treated entirely from the traditional point of view with regard to instinct, and despite a warning in the preface against attributing "human motives and reason where they have no existence," the "little architects" are more or less humanized throughout. It would seem that a no less popularly interesting book could now be written from the more modern point of view, dwelling on the failures and variability of instinct. However, for young English readers the book would no doubt accomplish the purpose set forth in the preface, of aiding "towards a greater love of animals and a desire to observe and understand their ways." But for the American reader its value is lessened by the fact that so few of the species whose behavior is described are natives of this country. This is especially true in the case of the birds: for instance, when the ovenbird is mentioned it is the South American *Furnarius rufus* that is meant, instead of our own little warbler, the discovery of whose nest is a pleasant achievement for any amateur naturalist.

Margaret Floy Washburn

[1] *Nature*, XVI., 182, 227.

Linseed Oil and other Seed Oils. An Industrial Manual. By William D. Ennis, M.E., Professor of Mechanical Engineering in the Polytechnic Institute of Brooklyn. 8vo, cloth, pp. 316. Price $4.00 net. New York, D. Van Nostrand Co. 1909.

This deals minutely with the production of linseed and other expressed oils, particularly cottonseed, sunflower, peanut and rape. A glance at the table of contents shows the wide scope of the book: this is as follows: Introductory, The Handling of Seed and the Disposition of Its Impurities; Grinding; Tempering the Ground Seed and Molding the Press Cake; Pressing and Trimming the Cakes; Hydraulic Operative Equipment; The Treatment of the Oil from the Press to the Consumer; Preparation of the Cake for the Market; Oil Yield and Output; Shrinkage in Production; Cost of Production; Operation and Equipment of Typical Mills; Other Methods of Manufacturing; The Seed Crop; The Seed Trade; Chemical Characteristics of Linseed Oil; Boiled Oil; Refined and Special Oils; The Linseed Oil Market; The Feeding of Oil Cake; Miscellaneous Seed Oils; The Cottonseed Industry.

The chapters on boiled and refined and special oils and the oil market are particularly instructive and valuable. Another chapter deals with the chemical testing of the oil, many of the methods being taken from the bulletins of the U. S. Department of Agriculture, Division of Chemistry. The method for the execution of the Maumené test can not be recommended. It is an open question as to whether chemical tests should be included in a manual of this kind.

The book occupies a unique place in the chemical world—similar books have been written in metallurgy—and it is hoped it will incite others to publish similar ones. It is most excellent and can be warmly recommended to all interested in seed oils.

A. H. GILL

SCIENTIFIC JOURNALS AND ARTICLES

The Journal of Biological Chemistry, Vol. VII., No. 5, issued May 20, contains the following: "The Determination of Small Quantities of Iodine with Special Reference to the Iodine Content of the Thyroid Gland," by Andrew Hunter. A method for iodine estimation consisting in combustion with sodium and potassium carbonates and potassium nitrate; conversion of iodide to iodic acid by chlorine; liberation of iodine by potassium iodide and titration of iodine by this sulphate. Details of the method have been carefully worked out and its limits of accuracy clearly defined. "Concerning the Relative Magnitude of the Parts Played by the Proteins and by the Bicarbonates in the Maintenance of the Neutrality of the Blood," by T. Brailsford Robertson. A confirmation of Henderson's results which showed that the bicarbonates of blood are more efficient in the neutralization of acid than are the proteins. "On the Refractive Indices of Solutions of Certain Proteins," by T. Brailsford Robertson. A formula showing the relation between refractive indices of solutions of ovomucoid and their concentrations is given. The change in the refractive index of the solvent brought about by adding 1 gram of ovomucoid to 100 c.c. is 0.0016; in case of ovovitellin, 0.0013. "The Origin of the Brown Pigments in the Integuments of *Tenebrio Molitor*," by Ross Aiken Gortner. Experiments are described which show that the pigmentation is the result of the interaction of an oxydase with a chromogen. The oxydase can be extracted from the tissue and is active only in the presence of oxygen. The chromogen is not precipitated by phosphotungstic acid; it is present only in minute amounts in the tissue at any one time. "Autolysis of Fertilized and Unfertilized Echinoderm Eggs," by E. P. Lyon and L. F. Shackell. Fertilization exercises little if any effect upon the autolysis of *Arbacia* eggs. "Studies of the Influence of Various Dietary Conditions on Physiological Resistance—I., The Influence of Different Proportions of Protein in the Food on Resistance to the Toxicity of Ricin and on Recuperation from Hemorrhage," by Nellis B. Foster, M.D. An attempt to determine in experiments upon dogs whether the vital resistance can be influenced by protein or non-protein diet. Results were indecisive.

NOTES ON METEOROLOGY AND CLIMATOLOGY

A THUNDER-STORM observatory has recently been established in Spain by Señor G. J. de Guillen Garcia. By means of a wireless telegraph instrument the electromagnetic waves set up by lightning discharges are detected graphically and acoustically, the changes in the intensity and the distinctness of the sounds produced in the receiver giving the observer a clue as to the probable path of the storm and the rate of its movement. After a sufficient amount of data have been obtained it is hoped that forecasts of these storms will be made possible.

THE promotion of Robert DeCourcy Ward to a professorship of climatology at Harvard University probably marks an epoch in the progress of climatology in the United States, as it is the first instance of an appointment to a full professorship in which the appointee is to devote his whole time to the teaching of the science. In the closely allied field, meteorology, Harvard also has a full professorship, Professor A. Lawrence Rotch, director of the Blue Hill Observatory, having received his appointment in 1906.

WHILE meteorological observations will receive but secondary consideration in the Mount McKinley expedition headed by Professor Herschel C. Parker, of Columbia University, they will not be neglected. Several portable instruments will be carried by the climbers, and a minimum thermometer will

be left at the summit, if that height is reached. Besides these, numerous recording instruments will be kept in constant operation at the base of supplies, a station just below the steeper part of the mountain. A comparison of the records obtained near the summit and at the base during the several months likely to be spent there will doubtless be of great value, and when the results are published it is not unlikely that they will form a distinct contribution to American mountain meteorology.

AMONG the eleven scientists whose names have been submitted for consideration in the next election to the Hall of Fame in New York city are those of Joseph Henry and Matthew F. Maury. The distinguished services rendered by these men to meteorology and climatology, as well as to other sciences, deserve the attention of the electors, and the selection of their names would at best be but a tardy recognition of pioneer American genius.

IN SCIENCE of March 11, reference was made to the changed character of *The Monthly Weather Review* of the United States Weather Bureau. The bureau now publishes three journals, *The Mount Weather Bulletin,* for scientific papers, *The Hydrological Journal,* reporting river-flow, floods and discharges, and *The Monthly Weather Review,* for climatological and engineering data. The first, a quarterly, is somewhat technical and is devoted largely to reports of the numerous researches being carried on at Mount Weather, while it is aimed to make the last a climatological summary and a great national engineering journal, in view of the growing interests in water resources. As it is a question whether or not it is proper for the government to expend public money for the maintenance of a popular or educational monthly, no journal of that nature is published.

BOOKS of especial interest to students of meteorology and climatology which have just been published or which will soon appear are as follows: "Descriptive Meteorology," Professor W. L. Moore; "Solar Researches," Dr. G. E. Hale; "Wind Pressure," Dr. T. E. Stanton; "Climates of the British Possessions," Dr. W. N. Shaw, and "Meteorology: Practical and Applied," Sir John W. Moore, new edition, illustrated.

REPORT has recently been made of the wireless transmission of meteorological observations made conjointly by the weather services of Germany and England during the months of February, March and April, and again in August and September, 1909. Vessels in the North Atlantic Ocean reported observations made at 7 A.M. and at 6 P.M., Greenwich time, to the coast stations of the Marconi Wireless Telegraph Company by means of an especially devised code. Even after making special efforts toward rapid transmission in the second series, but 43 per cent. of the evening observations, and less than 8 per cent. of the morning observations arrived in time to be of value. In commenting upon the results, "Prometheus" states that during the months of August and September not a single prediction of the Hamburg Weather Bureau was appreciably influenced by a wireless message. This may possibly have been due to the presence, frequently observed, of a great high pressure area extending westward from the British Isles, a phenomenon characteristic of spring and autumn. Under these conditions the distribution of pressure gives but little suggestion as to the coming weather in central Europe. It was found that when the pressure observations contained in the tardy messages were plotted after their receipt, in most instances there was no marked deviation from the distribution over the ocean as originally deduced from observations in Iceland and the Azores. In view of these facts it is not probable that further experiments of the kind will be made for a time, at least not until wireless telegraphy has advanced to a stage where messages can be transmitted with considerably greater speed.

LICK Observatory Bulletin, Number 169, contains a report of the expedition made to the summit of Mount Whitney last autumn when spectrograms of Mars and the moon were obtained under especially favorable cir-

cumstances. According to Hann's empirical formula for the distribution of water vapor in relation to altitude, 0.79 of the terrestrial water vapor is below 4,420 meters, the height of the summit, making the latter an admirable location for the experiments. The meteorological observations made by Professor Alexander McAdie, of San Francisco, who was detailed by the chief of the United States Weather Bureau to accompany the expedition, include records of relative humidity of but 1 per cent., or an absolute humidity of 0.06 gram per cubic meter. Professor W. W. Campbell, the director of the expedition, says: "We may feel satisfied, however, that an observer could scarcely hope for conditions more favorable for the solution of the problem before us, than those existing on the nights of September 1 and 2 on Mount Whitney; especially toward the middle of these nights, when Mars and the moon were near the meridian. Not only was the vapor in the air strata lower than 4,420 meters completely eliminated from the problem, but the vapor density at 4,420 meters was almost a vanishingly small fraction of the densities at all the observations where the Martian spectrum had previously been investigated."

In the recently issued report of the Smithsonian Institution mention is made of a Hodgkins grant for the erection of a small stone shelter on the summit of Mount Whitney, for the use of investigators during the prosecution of researches on atmospheric air. Mr. C. G. Abbot, the director of the Astrophysical Observatory of the Smithsonian Institution, began his observations there last summer, and obtained important data in the determination of the solar constant.

There has recently been placed on permanent exhibition in the Geological Museum of Harvard University, a model, in plaster of paris, of the mean hourly temperatures of Boston, Mass., which is probably the first of its kind. This model was made by the compiler of these notes as a part of the regular work in the research course in climatology given at Harvard by Professor R. DeC. Ward. It is two feet long and one foot wide, and its three dimensions show months, hours and temperatures. On one of the vertical sides lines are drawn, at equal distances apart, to show the twenty-four hours, and on the next vertical side twelve lines represent the months. The heights of the upper surface of the model, above the base, represent the mean hourly temperatures. This upper surface is divided into twelve areas, representing different degrees of heat and cold, and each area is colored, different shades of red being used for the higher temperatures, and different shades of blue for the lower. By means of this model it is possible to ascertain, easily and with great accuracy, the mean temperature of any hour of any month of the year. The data forming the basis of the construction are those obtained at the Boston station of the United States Weather Bureau during the period 1890–1905. The total number of observations used was 131,472. The modelling of climatological data in clay or plaster of paris is a new idea, and such models are likely to be of value in the climatological instruction of the future.

Although the committee of scientists appointed to determine the cause of the Paris flood with a view of preventing its future reoccurrence has not yet made its report, many authorities agree that the real cause was a geological rather than a meteorological one. The area drained by the Seine consists of a light soil, which, because of the gentle slopes, usually absorbs most precipitation, even though it be heavy or sudden. At the time of the recent heavy rains, however, the soil was either frozen or was saturated by previous rains, making its surface practically impenetrable to further moisture. The removal of the forests in late years from the higher regions of the river basin may or may not have been a contributory cause of the flood. As it occurred in the winter, vegetation could have but its minimum influence in checking the flow. The heavy and long-continued rains preceding the flood were general throughout the whole region, and because of the condition of the ground the run-off was rapid.

In the international observations of upper

air conditions made on May 18, 19 and 20, Blue Hill Observatory and the United States Weather Bureau furnished the American contribution. The former institution sent up pilot balloons at the observatory and sounding balloons at Pittsfield, Mass., while the Weather Bureau made their usual kite flights at Mount Weather and sent up sounding balloons at Omaha, Nebr. After ascending to a height of about eleven kilometers and passing through air at a temperature of about — 50° Centigrade, one of the four balloons sent up from Pittsfield descended in the Atlantic Ocean just east of Block Island, where it was recovered by the crew of a fishing schooner.

ANDREW H. PALMER
BLUE HILL OBSERVATORY,
HYDE PARK, MASS.,
May 26, 1910

SPECIAL ARTICLES

A SIMPLE AND ECONOMICAL AQUARIUM AERATOR

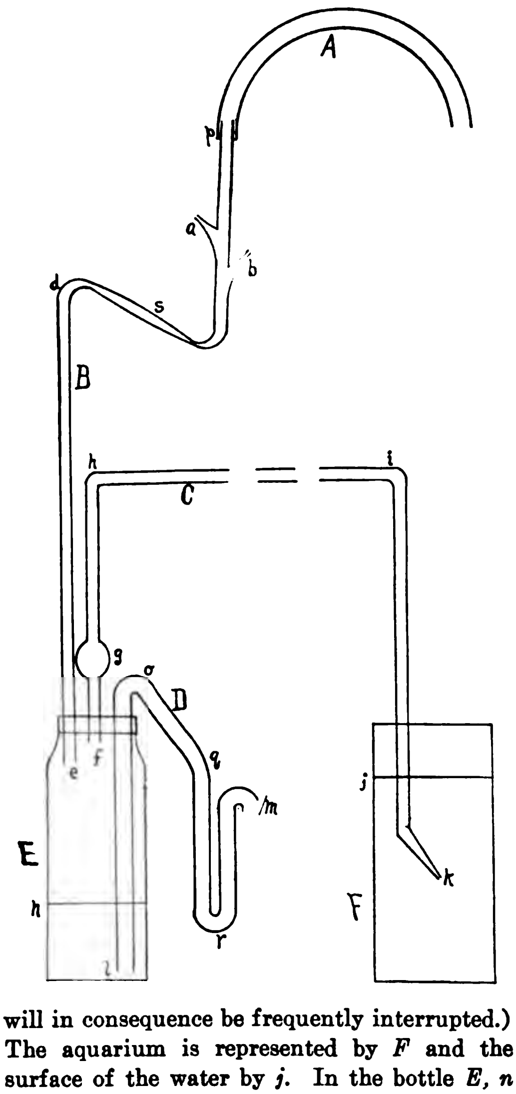
A SUCCESSFUL aquarium is a very rare object in undergraduate biological laboratories. The difficulties to be overcome in running an aquarium are generally thought to be so great that few are ever started; and if an animal happens to survive, it is usually considered an exceptional or an accidental case. There are, of course, good reasons for such a small number of aquaria. In the long run the various causes of non-success may generally be traced to two fundamental causes. These are insufficiency of food, and an insufficient supply of oxygen. In many cases the first of these defects is remedied by removing the second—an insufficient supply of oxygen. For when the food of an animal consists of living organisms, it is tolerably certain that there must be about the same amount of oxygen in the water for the food organisms to develop as is needed by the animal that feeds upon them. In other words, whenever the conditions are such that the food organisms can grow, the animal feeding upon them is also pretty certain to be able to live. Our chief concern seems to be therefore to establish a proper supply of oxygen to the water, and then knowing the food habits of the animal which we wish to put in the aquarium, we should not experience any great difficulty in keeping the animal alive.

There are many ways of aerating an aquarium, as might be expected, but there are always certain drawbacks, either in the simplicity of the apparatus, or in the economy of running it, or again in the irregularity of its action. The apparatus described below is the best which has yet come to my notice, as far as simplicity, economy and regularity of delivery of air are concerned. The apparatus is in use in the writer's laboratory and is giving perfect satisfaction on the three scores mentioned above, in addition to the important one of keeping the animals alive.

Before describing the apparatus it may be well to say that the aquarium should be stocked with water from the pond or stream from which the animal was taken, and not with "city water." The latter is often treated with chemicals to render it more fit for domestic use, as the precipitation of suspended clay by means of alum, etc. Water which has undergone this treatment is sometimes deleterious to animals, especially the lower forms.

Description of the Apparatus.—The tube *A* is of rubber and connects the aerator with the hydrant. Tube *B* is the "mixer." It conveys the water from *A* to the bottle *E*. As the water passes *a* and *b*, which are small open side branches in *B*, a quantity of air is sucked in and carried with the water into the bottle *E*. To obtain the maximum efficiency of the water as carrier of air, the tube *B* is drawn out to fine bore and bent at *c* and *d* in the form shown. The small bore causes all the water which passes down *B* to form drops filling the whole bore of *B*. Otherwise much of the water would run down the sides of the tube without pushing a quantity of air ahead of it. The tube *C* is of glass, or glass and rubber, as convenient, and carries the water brought down *B* into the aquarium through the opening *k*. The bulb *g* is for the purpose of preventing drops of water (which occasionally splash against *f*) from passing into the aquarium. The tube *D* is of glass and is what is known as a constant level siphon. Its purpose is to carry out the water which is col-

lecting in the bottle. To work properly it should have the form shown in the sketch. (In the siphon it is essential to have the part at *m* of just the form shown in the cut. If *m* is lower than shown in the sketch, the part *r* to *m* will act as a small independent siphon, and the stream of bubbles into the aquarium



will in consequence be frequently interrupted.) The aquarium is represented by *F* and the surface of the water by *j*. In the bottle *E*, *n* represents the level of the water while running. The bottle *E* is fitted with an air-tight rubber stopper with three holes through which the tubes *A*, *B* and *C* pass.

The mere description of the apparatus may not be sufficient to give a clear understanding of its action. Its mode of working may be briefly described as follows: Suppose the apparatus, as described, is connected up properly, as shown in the sketch, and the bottle is empty of water. Now on opening the tap, a little of the water comes down *A* and *B* and runs into *E*, carrying with it a certain quantity of air. Water and air collect in *E* until there is enough pressure to force the water into *D* so that it begins to flow out at *m*. The water will have reached a point a little below before the siphon begins to work. At first the siphon takes out the water faster than it is delivered into *E*, but finally there is reached a stage where the siphon draws out in a steady stream just as much water as is brought in by *B*, and in the same interval of time. This point is at *n*, and this is the permanent level of the water in the bottle as long as the apparatus is run. At the moment the level of the water reaches *n*, the tube *C* delivers air into the aquarium through *k* in a constant stream.

There must be more water in *B* below *d* than there is in *C* from *j* to *k*; otherwise the air could not be forced out at *k*. For this reason the greater the distance *d* to *e*, the more air will be carried into the bottle. (The ratio is not constant, however. Various factors seem to operate, as shown by experiment.) The distance *f* to *h* should be at least twice the vertical distance *j* to *k*, to prevent possible flooding of *F*. The siphon should be of a bore at least twice as great as that of *B* to guard perfectly against flooding.

It will be obvious that the vertical distance *j* to *k* can never be greater than the vertical distance *l* to *m*. Also that vertical distance *j* to *k* equals approximately vertical distance *n* to *m*.

The cut is a sketch of the writer's most efficient aerator. The cut is not drawn to scale. A number of different designs of siphons and mixers were tried, but those sketched gave the best results. One centimeter of water carries into the bottle (and therefore into the aquarium) from four to seven times the quantity of air (the quantity depending on the length of the tube *B* and

also on the flow of the water—the slower the flow the more efficient). This apparatus is therefore four to seven times as efficient as the ordinary air-displacement type of aerator, of which Dr. Pratt, of Haverford College, was so kind as to show me a working model last summer. But this apparatus does not use displaced air, since the siphon keeps the water at a constant level, and there is therefore no air to be displaced by water.

Another advantage which is of great importance is in the constancy of delivery of air. A constant stream of air bubbles without a second's intermission can be sent into an aquarium for weeks with this aerator with no attention whatever, providing the hydrant works well. With the air-displacement type this is of course impossible, since every time the bottle is filled with water, the current of air must be interrupted until the bottle is emptied.

Aside from the simplicity of the apparatus, and its constancy of working, its economy in the use of water will at once commend itself to all directors of laboratories who have limited funds at their disposal for running expenses. This aerator will deliver a constant stream of air, using only from 50 to 100 cubic feet of water per month. At the rate of 28 cents for 500 cubic feet of city water (the rate in Knoxville, an average rate), the monthly cost of operation would be only from 3 to 5 cents.

The writer's apparatus can be exactly duplicated by referring to the following measurements: *p* to *a*, 3 cm.; *p* to *b*, 6 cm.; *p* to *c*, 12 cm.; *c* to *d*, 6 cm.; *d* to *e*, 145 cm.; *f* to *g*, 10 cm.; *f* to *h*, 32 cm.; *j* to *k*, 16 cm.; *r* to *m*, 13 cm.; *l* to *o*, 38 cm.; *l* to *m*, vertical, 25 cm.; *h* to *i*, 5 meters; bore of *a*, 1 mm.; of *b*, 1 mm.; of *c*, 1.5 mm.; of *d*, 1.5 mm.; of *s*, 5 mm.; of *B*, 5 mm.; of *C*, 5 mm.; of *D*, 8 mm.; of *k*, 2 mm.; depth of water in *E* while running, 7 cm.; height of *E*, 38 cm.; contents of *E*, 8,000 c.c.; height of *F*, 24 cm.; contents of *F*, 7.5 liters.

ASA A. SCHAEFFER
UNIVERSITY OF TENNESSEE,
March, 1910

ARGYROSOMUS JOHANNÆ, A NEW SPECIES OF CISCO FROM LAKE MICHIGAN

HEAD 4.1 in length to base of caudal; depth 3.8; eye 6.5 in head; depth of caudal peduncle 3.1; snout 3.4; maxillary 2.6; mandible 2.0; height of dorsal fin 1.5; distance from snout to dorsal 1.9 in length; gillrakers 10 + 19; longest 1.0 in eye. D. 10 A. 12; scales 9–80–8.

Body deep, not greatly compressed, back strongly arched, rising rapidly for one half the distance from snout to dorsal, then more gradually. Caudal peduncle high, not greatly compressed. Head small, sharply wedge-shaped, its height at occiput 1.9 in height of body. Eye small. Lower jaw even with upper; maxillary reaching nearly to center of eye. Gillrakers coarse and widely set. Lateral line straight. Scales large and thick, non-deciduous.

Color (in formalin): lips and head pale; body dark above but not nearly to lateral line; quite pale below. Dorsally some indication of stripes, longitudinally. Dorsal and caudal fins with black edges, other fins pale.

Type: No. 372*d*, of the collections of the Wisconsin Geological and Natural History Survey, a male specimen 269 mm. in length, taken in about 25 fathoms some eighteen miles out from Racine, Wisconsin. Nos. 372, *a*, *b*, *c* and *e*, also Nos. 538, *a*, *b*, *c* and *e*, all from the same locality, may be considered as co-types. The specific name has been chosen as a slight token of gratitude for my great indebtedness to my life-companion.

The table on p. 958 gives the principal measurements of the specimens here included.

Early in July, 1906, the writer made collections of the fishes of Lake Michigan for the Wisconsin Geological and Natural History Survey. On a trip made with Captain C. Hyttel, of Racine, to his gillnets, set some eighteen or twenty miles out from that city, he had a good opportunity to observe and secure specimens of Coregonidæ. These did not, however, fall easily into groups conforming to the then known species. So the specimens were placed into lots according to their most marked external characteristics, and sent

Number	Sex	Length in mm.	Head in Length	Depth in Length	Eye in Head	Maxillary in Head	Dorsal Height in Head	Snout to Dorsal in Length	Caudal Peduncle in Head	Longest Gillraker in Eye	Gillrakers	D.	A.	Scales
372*c*	♀	229	4.1	3.8	6.2	2.8	1.4	2.0	3.5	0.9	10+17	10	11	9–91–8
372*e*	♀	232	4.1	3.7	5.6	2.7	1.5	2.0	3.5	1.1	10+18	10	11	9–82–8
372*a*	♂	248	3.8	3.8	6.5	2.8	1.7	2.0	3.4	1.0	12+19	10	11	9–76–8
372*b*	♂	250	4.0	3.8	6.2	2.8	1.5	1.9	3.4	1.1	9+18	11	12	10–92–8
372*d*	♂	269	4.1	3.8	6.5	2.6	1.5	1.9	3.1	1.0	10+19	10	12	9–80–8
538*d*	♀	217	4.2	3.9	5.8	2.6	1.4	1.9	3.3	1.3	10+19	11	13	8–87–7
538*h*	♀	223	4.0	4.1	5.1	2.8	1.6	2.0	3.7	1.2	11+20	10	12	10–82–8
538*c*	♀	224	4.1	4.1	5.4	2.6	1.5	1.9	3.4	1.1	13+23	10	12	9–83–8
538*b*	♂	228	3.9	4.0	6.4	2.9	1.6	2.0	3.6	1.0	11+17	9	12	9–80–?
538*a*	♀	236	3.9	3.7	6.7	2.6	?	2.0	3.5	0.9	10+18	10	13	9–90–8
538*e*	♀	237	4.1	3.8	6.4	2.6	1.5	2.0	3.4	1.1	11+18	10	11	9–80–8

to the laboratory at Madison. Unfortunately, the circumstances of the trip made adequate field notes impossible.

On taking up the study of these forms it immediately developed that lots 372 and 538 (with a few exceptions, not important here) differed from all the others, and indeed from all species of *Argyrosomus* so far known, by the fact that they had thirty or fewer gillrakers on the first gill arch. On further examination they displayed other differential characters, and it is these forms that are included under the new species described above.

Evermann and Smith ("Report U. S. Commissioner of Fish and Fisheries," 1894, p. 311) in 1896 described as aberrant forms of *Argyrosomus hoyi* Gill, eight specimens (five from Lake Michigan and three from Lake Superior) which undoubtedly belong to the species here described, agreeing with it perfectly as to number of gillrakers, the smaller eye, and greater body depth. They certainly are as near *prognathus* as they are to *hoyi*, but are not very close to either except as to lack of pigmentation on the head. *Argyrosomus hoyi*, as I understand that species, has the lower jaw so far included that it really resembles a *Coregonus*, and its upper lip is quite thick. *A. johannæ* has undoubtedly been largely confused with it. As far as my observations go, *A. hoyi* is not nearly so common as *A. johannæ*. However, that is a point on which I hope soon to make more detailed observations.

The form here described comes much closer to *A. prognathus* in its general characteristics, but is less robust and shows much less of the longitudinal striping of that species, while the number of gillrakers of course makes a wide difference.

In describing this form, after long deliberation, I have hoped to add something toward the elucidation of our North American Coregonidæ. Even the longest known forms of these are none too well understood, and abundant field work in many localities must be done before we can hope fully to clear up the status of most of them.

GEORGE WAGNER

WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY,
May 1, 1910

FIRST USE OF AMPHIBIA IN ITS MODERN SENSE

IN 1896 I urged the retention of Amphibia for the class then generally called, in the United States, Batrachia.[1] Cope strongly protested against such usage and affirmed that the name was not "introduced to take the place of Batrachia with a definition until a few years ago by Huxley."[2] Bauer soon proceeded to "show that the opinion of Professor Gill is the only one that can be accepted."[3] Several other articles followed in SCIENCE.[4] In fine, the name Amphibia has been generally accepted in the last few years in the United States as well as in Germany.

[1] SCIENCE, IV., 1896, p. 600.

[2] *Am. Nat.*, XXX., 1896, p. 1027.

[3] SCIENCE, VI., 1897, pp. 170–174.

[4] SCIENCE, VI., p. 295 (Wilder); VI., p. 446 (Gill); VI., p. 772 (Hay); XII., p. 730 (Gill); XX., p. 924 (Stejneger).

The original use of the name as a class designation in contradistinction from Reptilia has not been noticed, however. Baur only traced it back to 1822. It will interest herpetologists, therefore, to learn that it was formally used as early as 1806.

In 1806 Latreille published the first volume of his work entitled "Genera Crustaceorum et Insectorum" and in his introduction (I., p. 2–3) enumerated the twelve classes of the animal kingdom then recognized by him.[5] The third and fourth classes were vertebrates with a single ventricle ("cor uniloculare, sanguine frigido"), the third class ("Classis III[a]. Reptilia, Reptiles") having lungs only ("pulmones") and the fourth class ("Classis IV[a]. Amphibia, Amphibies") having both lungs and gills ("pulmones et branchiæ").

Of course these definitions do not represent modern ideas of the really distinctive characters of the classes in question, but neither does any old definition of any class embody modern concepts of the group intended to be diagnosed.

THEO. GILL

[5] In 1804 Latreille adopted the classification of Brongniart (1799) in which the amphibians were ranked as an order of reptiles ("Ordre IV., Batraciens, Batrachii").

SOCIETIES AND ACADEMIES

THE PHILOSOPHICAL SOCIETY OF WASHINGTON

THE 681st meeting was held on May 21, 1910, President Woodward in the chair. Two papers were read.

Methods of Measuring the Modulus of Bending of Flat Metal Springs: Dr. R. S. WOODWARD, of the Carnegie Institution of Washington.

This paper explained three methods for measuring the modulus in question. The first two methods assume that the spring is clamped horizontally and rigidly at one end and permitted to assume the shape due to its own weight. This shape is defined by the following differential equation:

$$d^2\psi/d\sigma^2 \mp -a\sigma \cos\psi,$$

wherein ψ is the inclination of the neutral surface of the spring at any point, σ is the quotient of the distance of this point from the free end of the spring by its whole length, and a is a number involving the modulus desired. The paper shows how to integrate this equation so as to give ψ, $\cos\psi$ and $\sin\psi$ simultaneously in power series of σ, and hence how to get the coordinates of any point in the elastic curve. When the latter are observed for the free end of the spring two equations result from which a and hence the modulus of bending may be found. Another equation from which a may be found results from equating the internal work of bending the spring to the external work done by gravity on the spring.

The third method of finding this modulus requires the application of a simple device which will bend a spring into a circular curve. The modulus of bending is then equal to the product of the applied bending moment by the radius of this curve.

Solar Radiation Intensities at Washington, D. C.: Professor HERBERT H. KIMBALL, of the U. S. Weather Bureau.

The results given are based on more than 7,350 separate determinations of the intensity of solar radiation made by the author at the Central Office of the Weather Bureau with an Angström pyrheliometer during the five years ending April 30, 1910. The observations were distributed over 272 half-day periods, or rather more than one half day to each week, and the radiation intensities are expressed in gram calories per minute per square centimeter of normal surface according to the Angström standard of pyrheliometry.

The maximum and the mean rates of radiation with a sky free from clouds were determined hourly or half hourly for a day in each month with average declination of the sun for the month. From these rates the daily and the monthly totals received on a surface normal to the solar rays, and also on a horizontal surface, were determined, first, on the supposition that the sky was free from clouds, and second, by taking account of the recorded duration of sunshine.

The maximum observed intensity of solar radiation, 1.44 calories, occurred in April, and the maximum for December, 1.32 calories, is only 8 per cent. less. The greatest monthly noon average, 1.28, occurs in February and the December average, 1.15, is only 10 per cent. less. The greatest daily total of radiation received on a normal surface, 971 calories, occurs in July, the corresponding December total being 60 per cent. as great. The greatest daily total for a horizontal surface, 653 calories, also occurs in July, and the corresponding total for December is only 30 per cent. as great.

The totals recorded by a Callendar horizontal pyrheliometer are very considerably in excess of the totals obtained from the Angström, the differences varying with the atmospheric conditions.

A diagram was presented showing variations in annual averages of radiation intensities at several stations, including Washington, and it was shown that a synchronism exists between minima of radiation intensities, minima of monthly mean temperatures in the interior of continents, minima of sky polarization when measured at the point of maxima, and maxima of distance of the neutral points of Arago and Babinet from the anti-solar point and the sun respectively.

(The abstracts of the foregoing papers are by their authors.)

R. L. Faris,
Secretary

THE CHEMICAL SOCIETY OF WASHINGTON

The 199th meeting was held at the Public Library on Thursday, May 12, at 8 P.M., with President Failyer presiding. The following papers were read:

The Exact Determination of Sulphur and of Barium in the Presence of Alkali Salts: I. K. Phelps.

By precipitating with $BaCl_2$ in a hot, neutral solution the contamination of $BaSO_4$ with foreign negative ions may be almost completely avoided and the precipitate contaminated with such positive ions as K, Na or NH_4 converted into pure $BaSO_4$ by treatment with H_2SO_4, evaporation and extraction of the alkali sulphate with water. In determining sulphur this alkali sulphate is converted into $BaSO_4$ by addition of the water extract to the mother liquor of the first precipitate. This second precipitate of $BaSO_4$ is added to the first and the process repeated. In determining Ba the water extracts are rejected.

The Determination of Nitrogen in the Fæces: I. K. Phelps.

The difficulties of loss of nitrogen by standing, of obtaining a uniform sample of the heterogeneous material, and of separating the hair from the fæcal matter when dogs are the subjects of study are overcome by preservation of the fæces under alcohol, filtration, dehydration of the solid material with ether and treatment of the solid residue and alcohol-ether filtrate separately. The solid residue is freed from hair by sifting and N determined in the usual way. The alcohol-ether filtrate is sampled and the N determined according to Kjeldahl, using the precaution to allow the alcohol-ether mixture to flow from a dropping funnel into the sulphuric acid heated and maintained at a temperature of 140–160°. Thus the large mass of the alcohol is converted into ethyl ether and excessive carbonization avoided and, at the same time, the acid kept of such concentration that all volatile nitrogen substances are held.

Oil Cement Concrete: A. S. Cushman.

The results obtained in a series of experiments in which oil residuums of an asphaltic and semi-asphaltic nature have been mingled with cement concretes while in a still wet or plastic condition were described. No difficulty has been experienced in getting homogeneous mixtures, and the initial and ultimate strength of the oil concrete appears to be only slightly less than that of ordinary concrete. It is hoped that the results of the investigation will lead to some valuable practical uses of this material, both for road surfacing and for waterproofing concrete in general.

The Complexity of the Humus Extract of Soils: E. C. Shorey.

This was a summary of the work of the Division of Fertility Investigations of the Bureau of Soils on soil organic matter. The author announced the isolation by him of twenty-three organic compounds from soils. Seventeen of these have been identified and eight types of compounds are represented.

The Separation and Determination of Cadmium in the Presence of Copper: E. A. Hill.

The use of filter paper pulp, pulped with an egg beater, is suggested for use in qualitative analysis for preventing the passages of finely divided precipitates through the filter and facilitating their removal therefrom.

In the solution of precipitates upon the filter the passage of the solvent is arrested by plugging the outlet of the funnel with a cork stopper, thereby giving the solvent time to act.

Cadmium carbonate is precipitated from solutions of copper by using ammonia free as distinguished from the ordinary laboratory $(NH_4)_2CO_3$ reagent in the former of which $CdCO_3$ is practically insoluble. The separation is delicate and complete (if heated) and affords a basis for both qualitative and quantitative methods which will be worked out later.

Arrangements were made to hold a special meeting at the Johns Hopkins University, to be followed by a smoker.

J. A. Le Clerc,
Secretary

SCIENCE

FRIDAY, JUNE 24, 1910

CONTENTS

MSS. intended for publication and books, etc., intended for review should be sent to the Editor of SCIENCE, Garrison-on-Hudson, N. Y.

THE OUTLOOK FOR A BETTER CORRELATION OF SECONDARY SCHOOL AND COLLEGE INSTRUCTION IN CHEMISTRY[1]

IF the question "Should more credit be allowed by institutions of college grade for work in chemistry done by pupils in secondary schools?" were asked of any considerable number of teachers in those schools it is easy to believe that the majority would make an affirmative reply, and that all would at least be inclined to add to the query the traditional language of the examination paper, "If not, why not? Give reasons for your answer." Inasmuch as the present conditions with respect to the correlation of the work in the two grades of schools is admittedly unsatisfactory, and since these conditions are essentially determined by decisions on the part of the colleges, it is fitting that the situation should be occasionally reviewed, with the purpose of finding out, on the one hand, how far the present situation can be defended and, on the other hand, of seeking means by which better results can be attained. Others have dealt with this subject from various standpoints, and the statements which follow are made less with the expectation that anything like a final word will be said, than the hope that a contribution of the experiences of the teachers in one more laboratory, and a few of the conclusions which they have reached, may do something to aid in the comprehension of one of the most perplexing

[1] Presented at the second decennial celebration of Clark University, Worcester, Mass., September 17, 1909.

problems which confront the teacher of elementary chemistry to-day.

The experiences here recorded have been gathered from the routine of instruction in a technical school, and it may be considered doubtful by some whether observations made in the laboratory of a technical school in which the instruction in chemistry becomes a part of a "step up" system of requirements (that is, one in which successful work in subjects of later years is directly dependent upon a thorough grounding in earlier subjects to a degree that does not obtain in the less rigid sequence of studies in the college) should be taken as a basis for conclusions bearing also upon college work; but, while such doubts may be justified in the case of a limited number of institutions in which chemical instruction is merely a part of a general college course, it is increasingly true that more and more students from all colleges are seeking the technical schools to complete some of the professional courses which they offer. In the case of the university the technical school may well be a part of its own system; in the case of the college it means that its reputation for efficiency in teaching is to be unexpectedly tested by some other group of instructors, and it should be as much a matter of concern to them to see that their students have an adequate preparation in the sciences as to see that they are soundly taught in mathematics or the humanities. Many of the colleges have much room for improvement in this respect.

Let us first look at the situation as it apparently exists at present in some of our typical institutions as indicated by the following brief summaries. The term "entrance requirement" is assumed to represent the work of a year with the ordinary time allotment for chemistry in the preparatory schools. The data have been obtained through direct correspondence with representatives of the institutions mentioned.

1. *Yale College.*—Does not require chemistry for entrance. Students may take an examination for advanced standing, but rarely do so.

2. *Harvard College.*—Those who have passed the entrance requirement take the same lectures as those who have had no chemistry, but they have special laboratory work and more advanced instruction in a special division. They are also allowed to take a first course in organic chemistry in the freshman year. Admission of such students to work in qualitative analysis has not proved successful. Those who present more chemistry than the entrance requirement are individually considered, but are rarely excused from college work on the basis of secondary school work.

3. *Cornell University.*—The entrance requirement is nearly the same as that of the College Entrance Examination Board, but the passing of this examination does not secure credit for introductory inorganic chemistry in the university. The student may take an examination for advanced standing if he desires.

4. *Columbia University.*—Those who pass the College Entrance Examination Board examination are admitted to a special course of lectures in chemistry, including a somewhat advanced treatment of the subject.

5. *Syracuse University.*—For one year of chemistry in a normal school credit is given for elementary chemistry in college, provided the student takes another course in chemistry and passes well. After one year of chemistry in a secondary school, pupils are allowed to take the regular examination in elementary chemistry, and if they pass, credit is given for that course. If chemistry is accepted for ad-

mission the student is admitted to second-year classes, but no credit is given for elementary chemistry.

6. *Washington and Lee University.*—Students from secondary schools with the equivalent of Remsen's "Briefer Course" are admitted to a course including physico-chemical topics and to qualitative analysis. If they do well, they are excused from the former at Christmas, and continue with analytical chemistry; otherwise they continue the course in inorganic chemistry through the year. A few students from selected schools are admitted at once to qualitative analysis, but no college credit is given.

7. *Washington and Jefferson University.*—Students from a few selected schools are given credit for the first year of chemistry in college, provided they take a later course in chemistry and attain a high pass record. Others are required to pass an examination before any credit is given. Chemistry is given in the sophomore year in this institution.

8. *Wellesley College.*—An advanced course is provided for those students who have had a year of chemistry. Smith's "College Chemistry" is used, and a somewhat exacting line of experiments is required. Some quantitative experiments, some volumetric analysis and some inorganic preparations are included.

9. *Chicago University.*—Students who have completed one year of chemistry in an accredited school are admitted to special courses and complete the work preparatory for qualitative analysis, or elementary organic chemistry, in about two thirds of the time required by beginners; that is, they complete two majors in chemistry in place of three. The work of these two majors is carefully adapted to utilize and clarify the knowledge already gained.

10. *University of Michigan.*—For a year of chemistry at an accredited school four hours of university credit are allowed (sixteen hours per semester is full credit). These students are admitted to a course somewhat less elementary than that given to beginners.

11. *University of Illinois.*—A full year of chemistry in a secondary school is accepted in place of one semester in the university, provided no more chemistry is taken (and provided chemistry is not offered for entrance). When the student continues in chemical subjects he is advised to take the regular course of lectures in chemistry, but spends less time in the laboratory.

12. *University of Wisconsin.*—Credit is given for entrance chemistry to the extent of one or two units out of fourteen. These students enter the same classes as the others, but have a slightly different laboratory course. In the course of two months they appear to be on about the same footing as those taking the subject anew.

13. *Lehigh University.*—Up to two years ago certain certificates were accepted from secondary schools but the results were so unsatisfactory that an examination has been substituted. Those who fail take elementary chemistry; those who pass are admitted to a course in theoretical chemistry.

14. *Sheffield Scientific School.*—If the student passes entrance chemistry, he is allowed to take an examination to pass off the elementary course in the scientific school, and if successful he is admitted to qualitative analysis. Very few students are thus admitted.

15. *Stevens Institute of Technology.*—Students pass an entrance examination like that of the College Entrance Examination Board, but the instructor finds that he can not make use of the earlier work,

and all students take a course in elementary chemistry.

16. *Worcester Polytechnic Institute.*—Earlier attempts to examine upon a limited portion of elementary chemistry with the purpose of definitely eliminating this from the college course were not successful. Note-books are now examined, and when these indicate a satisfactory course, the students are placed in separate divisions and given a different laboratory course. They attend the same courses of lectures as the beginners.

17. *Massachusetts Institute of Technology.*—Students who have satisfied the entrance elective requirement are admitted to a special class during the first term, and the lecture and class-room instruction, as well as the work in the laboratory, are designed to take advantage of the work already completed by the student in the preparatory school. The effort is made to introduce new lines of experimentation, as well as to reawaken interest in earlier work by encouraging the student to interpret the phenomena which he now studies in the light of his more extended experience, and with the aid of such additional concepts as have been introduced into the lectures and recitations. The two divisions of the class are united for the work of the second term.

Of these seventeen institutions one does not recognize chemistry for entrance, two make no specific provision for students who have had chemical instruction in the preparatory schools, three provide special laboratory instruction, but give no definite college credit, six provide special instruction in both lecture room and laboratory, but without giving college credit, while two give some college credit on certificate, and four excuse students from elementary college courses after special examination.

These institutions are sufficiently varied as to locality and type to justify the assertion that they represent the present practise on the part of thoughtful college teachers. That there is apparently much duplication of effort is at once evident, and that this must result in some loss of time, energy and enthusiasm hardly requires argument. Why, then, have we so long tolerated this apparent waste, and why do we not immediately take steps to avoid it? The answer seems to me to be this: It appears to be impossible to select any point in the chemical instruction received by the members of a college entering class at which they have such a sound understanding of the facts and principles already studied that this knowledge may safely be accepted as a foundation for further college instruction; or, if such a point may be selected, it lies so near to the beginning of the college course as to make a definite excuse from this small amount of work practically meaningless. There is, of course, a small proportion of students to whom this statement is not applicable, but it holds true of so large a proportion that it determines the character of the instruction which is given to all students who have had any previous chemical instruction. The situation does not appear to be appreciably better in institutions having a definite entrance requirement in chemistry than in others.

Some of the reasons for this state of affairs we will try to consider presently, but let us first look at the conditions as they confront the college teacher who has an earnest desire to enable his students to utilize every advantage which they have gained, remembering, however, that in these days it is not a question of individual but of class instruction, so far as the main features of a course are concerned. The college teacher or the teacher in a technical school will find among the members

of a single class students of each of the following types, with many variations:

Student A.—An intelligent, reasonably thoughtful pupil from a school where there are small classes, a well-arranged one-year course and a judicious, helpful teacher. Such a student is a source of constant pleasure, and much can be done for and with him.

Student B.—The chemical enthusiast who, during a course of one or two years' duration has been permitted, because of his enthusiasm, to work extra hours or to assist his teacher. He has won high praise and occasionally merits it, but too often the college teacher learns to dread the expenditure of energy and tact which is necessary to retain the good-will of such a student while bringing him to realize that a more profound knowledge than his own may be possible; yet, when the battle has been won, perhaps half of these men make excellent students.

Student C.—The student who has had two years of chemistry, in a course of ordinary excellence, under average conditions as to equipment and teaching. He feels, with some reason, that all this should count for a great deal, and no argument will wholly displace this notion. He works without interest, and generally badly, and is a heavy load to carry. You ask, Why not transfer him to the work of the higher years? We reply, Because experience has shown that he probably lacks adequate preparation for it, and will fail in it. The only practicable alternative lies in so arranging his laboratory practise that he shall have as large a measure of new work assigned him as it is possible to oversee without disproportionate attention on the part of the instructors.

Student D.—A student of moderate ability from an average school with a year of experience. His credentials are clear, but he has perhaps had little personal instruction and his knowledge is ill-arranged and vague, as to both fact and principle. He has no confidence in himself, and there is very little which is final in his preparatory work. His is one of the most difficult cases to provide for at the start, but often turns out well in the end.

Student E.—A student who has spent a year, or more rarely two years, under inadequate instruction, which has been worse than useless. An entrance examination may exclude him, but under other systems he becomes a troublesome factor in the complex problem and it may require some weeks to discover or be sure of his trouble. His place is with those students who take up the study of chemistry as beginners and his exclusion from the more advanced class is logical; but a transfer to elementary classes when these are provided is almost certain to breed discontent in the individual, and often disarranges other work of the term which, by that time, is well advanced.

But the confusion of interests does not end here! The types just referred to have been selected essentially along the lines of general efficiency of instruction and length of courses. It must further be recalled that even efficient teachers vary widely in their conceptions of the ground to be covered, and the college receives students who, during a single year of chemical instruction, have had the chief emphasis laid upon descriptive chemistry, others where it has been laid chiefly on "theoretical chemistry"; again others where the course is largely one of physics rather than chemistry; and, finally, where considerable qualitative analysis has been included even in this brief time.

The conditions appear, then, to be these, briefly stated: Experience indicates that the pupils who have had even two years of

instruction in secondary schools are, in general, not in a condition to take up work in chemistry which is more advanced than that of the first year in the college, and for students who have had but a single year there is at present so little that can be regarded as common knowledge that the present apparent duplication of work seems unavoidable. Regarding this duplication more will be said presently.

Let us next face the question, Why is it that secondary-school courses have failed, and, as it seems to me, are likely to fail, to serve as substitutes for any considerable amount of college instruction in chemistry? The reasons are far from simple, and they need some analysis. We may distinguish, I think, at once between certain factors which, since they are inherent in the nature of our science or in the period in the pupil's life in which the instruction is given, are common to all schools, and those elements in the situation which are the outcome of varying fitness on the part of the instructors.

Is it not true that chemistry itself presents some peculiar difficulties? It is often said that "physics is taught better in the secondary schools than chemistry." I am inclined to think that, as a general statement, it is essentially true. But might not the full truth be better stated in this form: "Physics is more effectively taught than chemistry in the secondary schools because physics is an easier science to teach"? It is true that chemical phenomena are plentifully at hand, and that our very life processes are dependent upon them; yet they are not recognized as such and are essentially unfamiliar. The teacher of chemical science, and the practitioner who seeks recognition for his achievements, are alike forced to realize that the tools which he employs, the working conditions which he establishes and the terms in which the results of his labors are to be expressed are unusual and strange and, because of this, more difficult of comprehension by his fellow men.

The beginner in chemistry is at a similar disadvantage as compared with the beginner in physics. In his work in physics the pupil handles, for example, the balance, the mirror, the pendulum or the battery, and he makes his measurements in units which are largely familiar to him; and the phenomena which he observes are not foreign to his daily life. On the other hand, the very test-tube and beaker to which the student of chemistry is immediately introduced are unaccustomed objects, the bottle of acid is still more so, and we often accentuate the situation by asking him to don breast-plate and armor for his personal protection, in the shape of aprons or rubber sleeves. While, on the one hand, the concepts and laws of physics may not be properly alluded to as "easy," yet it seems to me evident that they make less demands upon the intellect and the imagination than the fundamental principles of chemistry, if these principles are to mean môre to the pupil than mere memorized statements.

With the growth of the holes in the pupil's clothing the strangeness of the beaker, test-tube and acid bottle lessens, to be sure, but he is coincidently introduced to increasingly complicated phenomena; he is asked to conceive of molecules, atoms, ions, even of electrons; he is asked to form some notion of valence, to construct chemical equations, and to "state all that they express"—a thing which you and I with our greater wisdom and experience may well hesitate to attempt. He must master the principles of stoichiometry, that branch of chemical science which seems to baffle the human intellect to a degree that never ceases to amaze even experienced

teachers. It may even happen that his course includes such concepts as those of chemical equilibrium, the mass law, or the phase rule which, in their relation to the proper subject matter of a secondary-school course, somehow remind one of the records of those early chemical processes found in the first chapter of Genesis in which it is quite incidentally stated that near the close of the fourth day the Lord created "the stars also." It is easier to forgive the ancient recorder for his lack of a due sense of proportion, than to excuse the twentieth-century instructor.

Keeping in mind, then, the newness of the chemical processes and chemical concepts, and the fact that the latter necessarily make considerable demands upon immature imaginations, may we not fairly ask whether it is actually reasonable to expect that a young boy or girl of fifteen to seventeen will gain a really clear insight into chemical science in one year; such an insight as will serve as a safe foundation for a chemical superstructure without further strengthening through review? I think I can hear teachers answering warmly in the affirmative. But, again, do they not have in mind the exceptional rather than the average pupil? It seems to me that experience indicates that the most that it is wise to attempt in the case of the large majority of pupils of the ages named is to broaden their horizon by teaching them to interpret common phenomena in the terms of chemistry, and with the aid of only the simplest fundamental principles to help in the understanding of those terms, leaving the meaning of the more abstract conceptions to be learned in a college course, or by later and more mature reading if the pupil is not destined for college, but has an inquiring mind. I believe that the disparity between the immaturity of mind of the pupil and the demands of the subject-matter assumed to be taught has been far too much ignored. I think this is the more true in these days when it seems evident that our educational system, through its multiplicity of subjects and the over-prominence of the baneful influence of the examination paper, tends to remove nearly all opportunity for concentrated or independent thought on the part of the pupil, or of originality in methods of instruction on the part of the teacher.

I believe, then, that even the competent teacher, with adequate equipment and the usual time allotment must find great difficulty in teaching chemistry to even the more receptive pupils at the secondary-school age so thoroughly as to permit the college to substitute it for any considerable part of the college course, at least under present conditions. For, let it be said with all humility, we college teachers too often made a sad mess of it even with the advantages as to maturity and environment, which we presumably possess.

The statement is sometimes made by college teachers that they would prefer to receive students without previous chemical experience, and the question may be raised whether or not it would be better to abandon entrance requirements in chemistry. I believe it is the opinion of the majority of college teachers, especially of those who have given the problem the most careful thought, that this would be very unfortunate. I should consider it so for at least two important reasons: first, because, while formal excuse from a definite portion of the college work is not yet generally practicable, the experience already acquired by the student can be made very helpful if judiciously utilized, and second, because it is mainly through increased cooperation between the schools and the colleges in an effort to secure better working conditions

for the teacher, and the adoption of a rational course of instruction in the secondary schools, which will take into account all of the pupils, rather than those alone who propose to enter college, that we may hope to attain better results.

It is noticeable in the statements quoted above regarding the present practise in the various institutions, that the state colleges are apparently giving a greater amount of definite credit for work in the secondary school than the others. This is frankly stated by some of the college teachers to be due to the closer organic connection of the state university with the general school system, and is admittedly done under slight pressure. On the other hand, these institutions have, through the system of school inspection on the part of the state universities, a more direct means of influencing instruction in the preparatory schools. The outlook for better conditions in the future is generally regarded as favorable.

Perhaps we may ask just here, What would these better conditions be like? It is probably fair to say that they would be such as to avoid duplication of work. Obviously repetition and duplication should be reduced to a minimum, and no one would welcome changes which tend to bring this about more than I. But I think it is possibly true that there is less actual duplication of work than is commonly supposed in those institutions in which the students who have had a year or more of chemical instruction are segregated in separate divisions. Let us take a concrete case by way of illustration. The pupil in the secondary school prepares chlorine, using salt, sulphuric acid and manganese dioxide, or hydrochloric acid and manganese dioxide. The time available rarely permits the use of any other method, and the chemical changes involved are sufficiently complex to present some little difficulty for their complete comprehension. Few pupils, as experience shows, really understand that this is a typical, and not an isolated or unique procedure, and the rôle played by the manganese dioxide is but vaguely grasped. It *is* true that such students are asked to again prepare chlorine from these materials in the college laboratory, but they are at the same time required to study the action upon hydrochloric acid of such agents as lead dioxide, barium dioxide, hydrogen dioxide, potassium permanganate or potassium dichromate, and to discuss the changes involved from the common point of view of the oxidation of the acid, and the proportion of actual duplication of work is really small. Similarly, in the study of the action of acids upon metals, while it is desirable to ask the student for the sake of completeness to repeat the familiar process for the preparation of hydrogen from zinc and sulphuric acid, this becomes a mere incident in the series of experiments and in the broader discussion of all phenomena observed, which may well go so far as to include the principles of solution tension, in the case of such students.

It is, apparently, work of this general character which many college teachers are offering to those who have had earlier chemical training. The laboratory work is, as we have seen, frequently accompanied by lecture demonstration and recitations of a corresponding grade, and while it does not, of course, appeal to the student as a step in advance, as would some other procedure which seemed to give a stamp of finality to his earlier studies, it may well be questioned whether it does not better foster his intellectual welfare than the more alluring plan could do. It should, however, be the purpose of the college teacher to keep closely in touch with the actual and probably increasing average

attainments of the pupils sent to him, in order that he may take all proper advantage of the instruction already given, and it is probably true that a larger number of institutions should offer such moderately advanced courses than is at present the case.

I propose next to refer briefly to one or two specific points at which it appears to me that the instruction in the secondary schools might be improved. I do this with much hesitation, for I realize that those very details or methods which perhaps fail to appeal to me may well be very dear to another, and I realize that I should be loath indeed to have the actual efficiency of my own instruction judged by certain alleged quotations on the part of some of my students, or even by the subsequent acts of many of them. A conspicuous instance of the failure of some of our hopes was afforded by a statement made by one of our students in a recent written test that "nitroglycerine is used as a lubricant."

A question which many find difficult to answer is this: How far, taking into account existing and not idealized conditions, is it just to regard note-books as an index of the efficiency of the instruction as given in a particular school, or college? I shall not be rash enough to undertake to answer this beyond expressing a conviction that while a note-book which is well kept and carefully corrected probably indicates careful, efficient teaching, a relatively poor note-book may represent more accurately an overburdened condition of the teacher, which prevents adequate inspection and correction, than actual inefficiency in instruction. For it is often true that much of apparent error in the records may have been actually corrected in conference or class-room. This does not, however, apply to some of the atrociously bad specimens which are occasionally met with, nor, on the other hand, does it ignore those note-books which are obviously not records of work done, but studiedly prepared exhibits, executed through connivance of teacher and pupil at the expense of a fundamental principle of all scientific work, rigid honesty.

Is it not true that too many teachers are contented to have their students perform more or less perfunctorily the magic "forty experiments" which are said by some one else to represent a suitable course, rather than to vitalize their instruction by devising ten, twenty-five, fifty-five or any other number of experiments of their own to illustrate the facts or principles which they themselves desire to fix in the pupils' minds, and to see that these are actually discerned. The busy, often overburdened teacher, will not always find time or energy to devise an entire course of instruction, but the introduction of even a limited amount of well-considered experiments or class-room instruction which represents the personal equation of the individual teacher does much to maintain enthusiasm for the teaching which is often reflected in the work of the pupils as well.

The deadening tendency of a mere following of a course of experiments laid down by others shows itself also in a disposition to regard each experiment as a thing apart, the nominal completion of which is a cause mainly for relief, is also reflected in many instances in the notes submitted, which are long and minutely descriptive of really insignificant details, but miss the real point of the experiment. This, in turn, comes from the fact that the pupil is not sufficiently informed why he is asked to perform the experiment at all, and in the strangeness of the work he naturally confuses the important and the unimportant. For example, he is often apparently left to think that a description of

"the apparatus used" is as essential when he pours silver nitrate solution from a bottle into a test-tube containing a halide solution, as when he is preparing nitric acid from saltpeter, and he elaborates his descriptions with the same fidelity in the former case as in the latter, with a very considerable aggregate loss of good energy on his part and that of his instructor. But that is not the worst of it, for he gains an idea that all experiments are to be treated with similar uniformity in other respects, even including his search for their hidden meanings. I do not, of course, advocate telling the student what is to happen and then asking him to say that it did occur, adding, possibly, the color of a precipitate; but I do believe that a great deal would be gained if nearly all experiments, or groups of experiments, were more carefully prefaced in the laboratory directions by a brief statement regarding the principles or the types of changes involved, and if, then, the student were encouraged to make his observations with reference to these statements and were required to show that he understands how the given experiment actually confirms the points in question. This would do much to avoid what is at present a wasteful expenditure of time, muscular energy and eyesight—all of which could be used to increase the pupil's experience, and it would partially, at least, eliminate the vague groping which results as those appalling scientific monstrosities which follow the words "I conclude" in the note-book of many a conscientious student. Have you ever recalled the bewilderment of your student days, when you had no idea what to look at among so many phenomena? Have you ever taken a half dozen experiments and candidly asked yourself what *you can legitimately conclude* from what has been performed? It is very much like trying to answer some of one's own well-sounding examination questions; a procedure which often causes them to lose their attractiveness.

Do we not, then, tend to lay too much stress upon mere performance of experiments, and devote too much time to the making and reading of descriptive notes which are often copies of the experiment manual, and too little time to helping the pupil, through judicious suggestions regarding the experiments and through questioning at the work-table and in the recitation room, to comprehend what it is all about, and the relation of a given experiment to others already performed?

In order that the perplexities of the college instructor may be brought more clearly to mind, and in order to illustrate certain types of note-books, I reproduce here a few pages from the books presented in connection with the entrance elective requirement of the Massachusetts Institute of Technology.

FIG. 1

The first (Fig. 1) is a representative of a rather small number of superior books. The observations are carefully recorded, the deductions are valid and well expressed and there is evidence (not shown in the cut) that the note-book had been inspected

and corrected. Under existing conditions as to numbers of pupils to be taught it is probably too much to expect that all will attain a standard which this note-book ap-

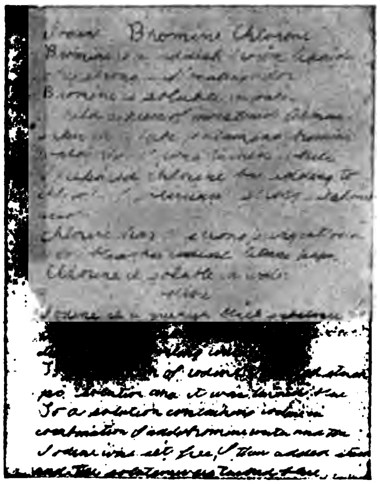


FIG. 2

pears to represent. To all appearances the records are original and the instruction efficient.

The pages reproduced in Figs. 2 and 3 are of a not uncommon type. The first

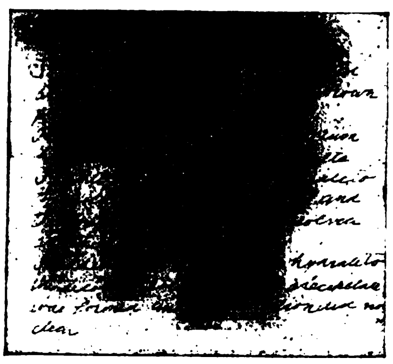


FIG. 3

leaves one in doubt as to what part of the work has been performed by the pupil, since the statements made regarding the physical properties could have been copied from a book, the records of experiments performed are distinctly wrong and, in the case of the alleged preparation of chlorine, would, if ever followed, lead more directly to a residence at a hospital than to any worthy scientific end. Fig. 3 shows a page which makes no pretense of being anything more than a mere record of a useless mixing of a few solutions, and moreover these records are also entirely wrong.

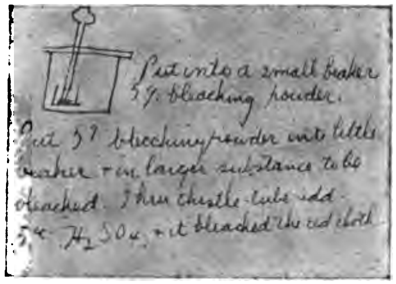


FIG. 4

The two pages just commented upon did not bear any evidence of inspection on the part of the teacher; that shown in Fig. 4 bore the stamped legend "approved," but a careful inspection leaves one in doubt as to what particular feature of the record warranted this, unless it may be the evidence of sympathy (?) on the part of the pupil with the tendency towards spelling reform.

These are not exceptional pages; they are representatives of many that pass under our inspection each year, and I ask you, with all sympathy for the teachers concerned, what evidence does any but the first give that one may safely omit a review of the ground supposed to be covered by this work in a college course which is primarily expected to furnish a safe foundation on which there is afterwards to be erected a very considerable superstructure of chemical knowledge? Are we not justified in our perplexities?

I should like also to appeal to the teachers in the preparatory schools to encourage

the pupils to better economize their laboratory time. Too many are allowed to placidly watch a crucible heat, or a solution boil, when other experiments might be in progress at the same time, and these habits are difficult to overcome. I should like to suggest, too, that some of the most promising pupils are often seriously harmed by allowing them to work too much by themselves, or by encouraging them to go beyond their depth in a particular line in which they appear to be specially interested, to the detriment of their fundamental work. Such pupils usually come to college with an exaggerated sense of their own attainments and it frequently requires long and tactful persuasion on the part of the college instructor before they can be reduced to reasonable humility.

On the other hand, I venture to plead that all proper encouragement be given to pupils to take advantage of such special privileges as the colleges offer. It is not an infrequent occurrence to find a pupil who tells us that he has been advised by his teacher to take the elementary course for beginners as one in which he will incur less risk of failure. Were the examination the goal of the course, there obviously would be little to criticize in this suggestion; its effect upon the student as an embryo scientist is seldom happy.

In conclusion let us ask, how can we make the work in chemistry in the various institutions more mutually helpful?

1. By a more extensive cooperation on the part of the colleges and technical schools in the way of separate courses for those who have taken chemistry before entrance, a closer study of the problem on the part of all, and a readiness to recognize improved conditions.

2. By an intelligent delimitation of the secondary-school course, so that it will only offer what the pupil can best assimilate at the age and in the environment in which he works. This is too large a topic for discussion in this connection, and it is sadly complicated by the necessity for furnishing a course which shall be alike useful for the pupil who expects to enjoy college opportunities and his less fortunate associate. I plead, as I have often done, for a course which is fundamentally descriptive in its character. I do not mean a mere catalogue of facts, but a course in which selected facts are taught for some specific reason, which is invariably explained to the pupil, and in which these facts are interpreted for him in terms of the simplest of the fundamental principles and concepts, so often repeated and constantly utilized that they may ultimately mean more than memorized paragraphs from what he may later remember only as "a book with a green cover." I think there can be no greater mistake than to suppose that such a course is a less worthy one than such as is often pointed to with pride as a "theoretical course," and no teacher should consider that it will demand less than his best efforts, supplemented by all his knowledge, to utilize the opportunities for helpful and thorough instruction which such a course affords. It is, of course, difficult to determine whether or by how much the instruction of the boy or girl destined for college should be differentiated from that of their fellow-students, but I venture to hope that a decision may yet be reached, through cooperation, which may permit us to select a limited field which shall be so well covered as not to necessitate repetition in college, and that this may be done without prejudice to the candidate or non-candidate for college credits. How soon this will come, or how large this field may be, I do not venture to predict.

3. By increasing the time alloted to chemistry in the secondary schools until it

is more nearly commensurate with the dignity and difficulty of the subject. Whether such increase should amount to one third, or some larger fraction of the present time allotment is a point which those actively concerned in the teaching can best determine. The increase in time should be asked for mainly in the interests of those who will not pursue the study of chemistry further, but it will also presumably hasten the time when a definite point of articulation with the college work, as just suggested, can be fixed.

Finally, there is the urgent need of decreasing the demands made upon the teacher of chemistry in the secondary school for duties other than those of chemical instruction, and also a critical need for relatively more instructors. I believe that a very large proportion of the unsatisfactory results now noticeable are due to the fact that in most of our schools it is not humanly possible for the teaching force to accomplish what should be expected of them, or to be at the desk of the pupil when he reasonably needs assistance. In some schools which have come under my observation the distribution of supplies must be attended to by the senior (or often the only) instructor, an operation which consumes a half hour or more. Probably no science demands for its understanding by the beginner more individual instruction in laboratory and classroom than chemistry, and the school authorities should realize this. When they do we shall have much cause for rejoicing, and much of the present groping and bewilderment on the part of the young student will give place to enjoyment in the study of a science which is really second to none in its attractiveness or value when pursued under favorable conditions.

It is a pleasure, in closing, to say that I feel that too much praise can hardly be given to the loyal, hard-working, intelligent and inspiring teachers who are accomplishing so much in behalf of our science in the training of the beginners. No thoughtful college teacher can fail to recognize the good work done in very many schools throughout the country, and while many feel that more definite recognition in the college curriculum can not wisely be given to this work at the present time, I am sure from the messages which have recently come to me from many colleagues in many institutions that there is an increasing appreciation of the fact that the way to better things lies through a sympathetic appreciation and study of our common problem and our common difficulties.[2]

If there be a determination, on the one hand, to undertake only so much as can be well taught and to give the largest practicable vitality to the instruction, and, on the other hand, a disposition to promptly recognize and utilize every bit of ground gained which offers a secure foundation for later work, a more satisfactory situa-

[2] In a discussion which followed the presentation of this and other papers on educational topics, a statement was made by a secondary school teacher of recognized standing to the effect that many such teachers had become indifferent to the opinions of college instructors, since it is "impossible to satisfy them any way." While I heartily sympathize with the thoughtful teacher who desires to teach his subject in his own way and with his own ideals in view, and deplore any attitude of the colleges, collectively or individually, which tends to interfere with this, it seems to me that the common cause of greater total efficiency in instruction can hardly be served by ignoring the opinions of the colleges, even if they are mistaken. May it not be true that the secondary school teachers lack some courage, or at least some persistence, in forcing their convictions upon the college teacher? They have the privilege of speaking from a fullness of experience with the young pupil which the college instructor usually lacks.

tion than that which exists at present can hardly fail to result, even though the degree of recognition of secondary school instruction may fall short of that which some desire.

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HIGH SCHOOL CHEMISTRY: THE CONTENT OF THE COURSE[1]

Every teacher in the high school of to-day finds himself in stimulating circumstances. He is obliged to question himself closely as to the part that his subject plays in the curriculum, for, at least in the large cities, the long-discussed change in the character of the high school is upon us. The reason for the change is found in a realization of the facts that in the past, high school education has been enormously wasteful; that eighty to ninety per cent. of our pupils do not complete the course; that only a small part of the remaining per cent. achieve the purpose for which the whole course has been framed, that of entering college. The evidence that the change has actually begun is found in the establishment of trade and vocational schools, in the frequent discussion of questions pertinent to these points, and in the statements of principals and superintendents that something must be done to stop the enormous educational waste; and in their declaration that the high school must meet real needs, must give the boy or girl the education that is best for him or her, as a member of the human group, with little reference to college entrance.

Among the changes that are coming from a recognition of these facts, we find the importance of science in the high school largely increased. The fact that it is science that has produced the great material advance of the past century makes it certain that in the further turning from formal to practical education, science will play a larger part. It is the purpose of this paper to inquire into the manner in which these changing conditions are reacting on the high school course in chemistry, and to discuss some of the considerations that are determining, or should determine, a new course of study. The speaker wishes also to discuss, in general, the problem of high school chemistry, presenting personal and perhaps even extreme points of view.

We may classify the various forces that are shaping the new course as external and internal. In the first class we find: (*a*) a lessening of the college influence, due to a realization of the necessity of educating for other purposes than college entrance; (*b*) a tendency to put chemistry earlier in the course and to give a second year of it; (*c*) what we may call the lay demand for practical education.

The lessened college influence will give to the body of secondary teachers not only greater freedom in the selection and arrangement of their material, but what is of even more importance, because it serves as a stimulus to their creative ability, a realization of the importance of their own great work and their responsibility for it. The lack of this kind of freedom is in part responsible for the condition that exists to-day when the high school, paying comparatively high salaries, can not get enough good men, while the college apparently has more than it needs at a smaller compensation. This is not the least of the evils that have resulted from the college domination of the high school. Others have often been pointed out and are well known. The course of study can never be adapted to the real needs of the high school so long as it is framed by the

[1] Presented at the second decennial celebration of Clark University, Worcester, Mass., September 16, 1909.

college, at the best a force operating at a distance, at the worst a power acting for needs it can not know. The college, as far as the high school was concerned, always had the idea of preparation, not growth, in mind. A thousand boys went through a course in chemistry whose nature was determined solely by the needs of the three or four who were to be trained to be expert chemists. It is often said at this point that the course which best prepares the pupil for advanced work is also best for every other boy. It is nearer the truth to say that the education which best meets the needs of the growing member of the human whole ought to be the best preparation for college.

Chemistry earlier in the course and perhaps a second year of it; the first of these conditions may bring dismay to many teachers; the second, delight to all, surely. Certainly some changes in the traditional course are necessary in teaching chemistry in the second year. On this point the speaker can refer to an experience covering nearly seven years. During all that time chemistry has been taught to some second-year students. At times fourth-year students and second-year students have been taking nearly the same course simultaneously in separate classes; at other times the two terms of students have been mixed in the same class. In both cases a certain degree of success with the second-year students has been obtained, even if we judge by no other standards than results of college entrance and state board examinations. Speaking for the moment from the standpoint of the college entrance syllabus, but little change is necessary to adapt the chemistry to second-year students. A less rigorous insistence on the philosophical development of the atomic and other hypotheses seems to be the most necessary item of change. In any case, as far as the ability of the student to comprehend is concerned, the difference between individuals is much greater than the difference between second- and fourth-year classes. The general average of work is considerably better in fourth-year classes, but this is explained largely by the dropping out of weak material.

To meet the demand for practical education, we find that there is a decided tendency to introduce into the high school a great deal more of chemical technology than there was in the older course. There are some who go so far as to say that the high school ought to give the pupil a means of earning his living; that chemistry should be taught so as to fit him for some direct employment in practical occupations. While admitting this as a possible ideal, the view implies such an extreme change in the character of the high school that it is not advisable to take it into consideration in the present discussion, except to admit that, given time, it would be possible to accomplish this result. Along with the demand for technical education, we find a tendency to fill the course with a great deal of matter that is associated with the home and every-day life. These two demands have come largely from without. They have done great good and have added much to the human interest of our science. We teachers are very prone to an academic point of view, and the stimulus has been a needed one. Yet with the good, there is some danger. There is a tendency in some quarters to emphasize the technological details of processes, to fill the discussion with technical terms, so that the pupils' talk bristles with tuyères and downcomers and the particular names of the many towers that find application in manufacturing chemistry. The chief evil of this kind of instruction is that it produces rather showy results, it seems to indicate more knowledge

than really exists. Moreover, a technical process of to-day is a very complicated thing. It is improved every year and we find to our discomfiture, on visiting the factory, that the process we have so carefully learned from the text-book differs in a hundred details from that actually employed.

The chemical interpretation of the ordinary phenomena of the household is a very interesting matter. Unfortunately many of these interpretations are very complex, others are unknown. Some are simple enough to be comprehended by a beginner, and certain food tests and the like can be taught so that the pupil can go through them in a more or less mechanical fashion. But surely these do not constitute a suitable vehicle for the transmission of that highly organized mass of knowledge and way of thinking which we know as chemistry. The intellectual and material advance that our science has brought to the world has not come from the knowledge of isolated test-tube reactions, but from the brilliant imaginings of the authors of its great hypotheses, from the realizations of its tremendous generalizations, from the perceptions of most deeply hidden relationships among the things that we call matter. If this that we teach our pupils is to bear the name of chemistry, it must give them at least a glimpse of these deeper things. Technological chemistry and household chemistry have a very proper place in the high-school course, but they should not be over emphasized. They afford the illustrative material which the good teacher will constantly use to give interest to his work by showing what good the science has brought to mankind. But a course composed almost wholly of such material, as has been proposed, would not be chemistry, and it would probably not be science. There would be an absence of principles, of relationships. A pupil might indeed learn that there exists a simple process for the manufacture of soda, but he would not share in any degree the kind of thinking that has made this and a thousand other processes possible. I hold that it is our chief duty to give him this kind of knowledge.

Coming then to the internal considerations which shall help shape our new course of study, we must inquire what high school chemistry should seek to accomplish for the pupil. One way of answering this question is by asking ourselves what it has done for us as individuals. We know that it has made us broader men and freer human beings, and it is fitting that we should seek to have our pupils attain in some degree this high end. Again, it is certain that one who has been through a good course in chemistry, who has learned the principles of chemical action, and comprehended the great laws that the science has revealed, looks upon the world about him in an altogether new way, so much so that with the increase in the general knowledge of science there is being produced a new type of world mind. Our pupils must be taught so that they shall share in this new world mind.

THE LABORATORY ASPECT OF THE COURSE

The course will continue to be based on experiment, the amount of laboratory work being limited only by the physical possibilities of the situation. The experiment will precede the class discussion in order that the pupil may conceive the things that he is talking about as realities. Chemical thinking can not go far without these definite conceptions. It requires images of real things, and it is this point of view that should determine the character of our laboratory work. There seems to be considerable difference of opinion, if not confusion, on this point.

There is the point of view which assumes that it is the purpose of the experiment to

prove the statement of the teacher or the text. Because there was so much that was bad in reliance upon authority in older types of education, it is felt that science must have none of this, but must accompany everything by rigorous proof. Following this method at its worst, the pupil is stimulated into a condition of perpetual doubt. He meets every statement with a but, and has rather the air of believing that some scientific charlatanry is being imposed on him. This is wrong; science does not have this attitude of perpetual doubt. It requires the most rigorous proof from discoveries of new things, but if each of us had demanded ocular demonstration at each step in our advancing knowledge, we should probably still be somewhere in the realm of descriptive inorganic chemistry. Moreover, it is a serious scientific mistake to let the pupil think that a single experiment performed under the ordinary condition of the beginner's laboratory proves much of anything. If it does, the speaker has seen many curious things proved in his time. Let us be frank: these experiments show at best the line of thought by which the proof is obtained. They illustrate the proof—they do not give it.

Nor does the theory that the pupil should, in the laboratory, rediscover the fundamental truths of the science, give us a right basis for experimental work. Followed to the extreme, this method soon reduces itself to an absurdity. Take, for example, the experiments of Lavoisier, which afford such an excellent starting point in the teaching of the subject. The pupil is given some metals and a balance, and is supposed, in an hour and a half, to rediscover what it took the best minds the world then possessed several centuries to accomplish. The fact the pupil's laboratory record, duly attested by the teacher, indicates that he independently accomplished this prodigious feat is a comment on the system. All that is done in this method at its best, is the arousing of the pupil's curiosity, which is later gratified by judicious suggestions at the proper moment from the teacher. There is no rediscovery; the line of thought has simply been retraced, and the big steps have been taken by the teacher. To be a discoverer you must be the author of your own curiosity. Another trouble with this method is that once committed to it the teacher is driven to curious round-about expedients to prevent the pupil's having knowledge in advance of the thing he is going to see. There are hundreds of instances where the pupil should have this knowledge in advance.

The speaker is more and more convinced that while the laboratory should to a certain extent seek to accomplish the things which the holders of two points of view consider desirable, its real purpose is to afford illustrative material, and by illustrative material he means that which will give concrete ideas—images—of things and processes. One might read hundreds of pages about chlorine, but if he had never seen it he would never know it. This is the great work of the laboratory method, to teach things and not literal symbols for them. We should seek this end, and let other considerations give way to it.

And we shall not neglect to exercise the pupil's scientific imagination. Chemical thinking requires this faculty. After he has been well grounded in the method of the laboratory, we shall want the pupil to learn to foresee chemical possibilities. The progress of the science has been by the working together of experiment and imagination, the one reacting upon the other and each suggesting in turn new steps in the advancing knowledge.

THE CLASS-ROOM ASPECT OF THE COURSE

It is no longer being framed exclusively

for the college entrance requirement; our course will not require us to cover so much material as it did formerly. Discussion of the rare elements and their compounds will give way to a more intensive study of those that show typical chemical actions, and establish the main lines of thought. We shall prefer to do this by reference to the things of the practical life where we can, but we will not go into the chemistry of foods, dyes, textiles and the like, knowing that this matter is far too complex for us to use in establishing the laws and relationships that are necessary for a comprehension of the science. We shall draw from every aspect of chemistry in our effort to establish the principles of chemical action. Our teaching may grow less descriptive and more dynamic. We may find it better to study types of chemical action than to study elements and compounds. As suggestion along this line, we might proceed, after reaching the definitions of chemical action, element and compound, to the general study of simple decompositions, using many experimental illustrations. We would bring in the ideas of stability and heat of formation. We would then proceed to direct combinations, simple replacements, and so on until finally the pupil would have a very good idea of the comparatively few types of chemical action. He would acquire incidentally a very practical descriptive knowledge.

Our course will necessarily continue to pay a large amount of attention to chemical theories, in order that we may have the means of seeing analogies and interpreting results. The mechanism of chemical changes is so far removed from direct observation by the senses that any attempt to comprehend these must be largely by aid of the imagination. The atomic theory has given us a splendid instrument for this purpose. We should retain it even if it had done nothing more than give us a system of chemical formulas, or made it possible to represent chemical actions by equations. Only one who has attempted to teach chemistry without the use of these symbols can fully appreciate what a tremendous aid they are. We shall therefore want to establish the atomic theory rationally, and to show how formulas are determined. This is perhaps the most difficult part of our work, but the fact that many pupils fail utterly to comprehend this matter is no ground for its omission from the course. There are many who succeed, and we must not forget that those who fail at least learn that such knowledge was acquired by human reasoning and patient experimenting. We should make our pupils feel that these theories are very practical things indeed, since it is largely by their aid that the science has advanced and brought material benefits to mankind.

We have in the past been given to considerable drill in certain types of chemical problems, largely because of the demands of college entrance examinations. There has been a good deal of mental gymnastics in the matter. These calculations should be taught in a less formal way; the laboratory is the best place to do it. Let the pupil calculate from the equations the quantities of substances he needs for his reaction, and then actually mix them in these proportions. Let him get practise in correcting gas volumes in the course of experiments involving simple gas measurements. Knowledge acquired in this way has a far greater staying quality than that obtained in formal class-room drill.

As we have already said, chemical technology will find a place in the course, but it must be taught by principle too. In the Solvay process, for example, it is more important that the pupil should get the idea of precipitation by differences in solubility than that he should know the mechanical details of the carbonating towers.

It is more important he should know that the process is only commercially profitable because the ammonia is recovered, thus getting hold of the principle of the utilization of by-products, than that he should know the factory terms for the machinery and operations. A good course in manufacturing equipment, in which different types of furnaces, towers and the like were grouped and compared might be of great practical and educational importance. But isolated bits of such information have no such value.

Our high-school chemistry might well include a treatment of more organic compounds than it has in the past. This knowledge can readily be acquired by reference to inorganic types. So many of the simpler derivatives of the hydrocarbons are things of every-day life that in order to include them we can afford to sacrifice some of the things of the traditional elementary course. The pupil needs, moreover, some intimation of the character and extent of the organic branch of the science.

In conclusion, the speaker feels that the best hope for the improvement of high school chemistry lies in discussions of the kind we are engaged in this morning. The experimental end of our work has been so new and interesting that much of our time has been spent on these matters. But the time is at hand when a reconsideration of the course as a whole in its general relations would be of benefit to the teaching of the elementary science.

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CHEMISTRY IN SECONDARY SCHOOLS[1]

IT is not necessary in a gathering such as this to recount the stages in the history of chemistry teaching in secondary schools —how, from the purely descriptive natural philosophy of the early college we finally essayed the teaching of chemistry and physics as sciences; how the miscellaneous encyclopedic instruction has been replaced by courses, designed, in these latter days, to develop power for the pupil rather than to impart knowledge.

The changes in content and method of formal secondary-school instruction have been brought about by the colleges; by advice, by supplying the teachers and most drastically, by the requirements for admission. While the bulk of the class might pass from the school and not be heard from again, the failure of a pupil to pass the college examination is quickly brought home to the teacher, so that the entrance examinations have become the standard of the school.

During the last fifteen years four syllabuses have been published which have decidedly affected the teaching of chemistry in schools; in 1894 that of the Committee of Ten, descriptive and general; in 1898 a Harvard syllabus, largely quantitative and scientific in method; in 1900, the syllabus of the College Entrance Examination Board, a plan for a course I hesitate to classify; in 1905, the last revision of the syllabus of the New York Department of Education, a historico-systematic course.

There is almost nothing in common to these four courses, and although the College Entrance Examination Board maintains and strengthens its hold upon the schools it has never, fortunately for the pupils, conducted its chemistry examination in accordance with its syllabus.

If we examine the texts to find what is being taught in high schools we find the chemistry text-books to be descriptive or theoretical; very few have successfully

[1] Presented at the second decennial celebration of Clark University, Worcester, Mass., September 16, 1909.

combined the two. The descriptive texts usually become encyclopedic, try to include all the elements, strange compounds, the latest processes and weird discoveries, often curtailing or entirely displacing those common things we are too liable to take for granted that every one knows. The theoretic texts are largely the product of college men. These tend to become too abstract and sacrifice the pupil to the subject. One elementary text of very wide use devotes two pages to a discussion of the action of bleaching powder, but does not state how it is used or for what goods.

If a subject is to be treated as a science many facts must be given and understood in order that the pupil may acquire a comprehensive idea of the subject. It is folly to expect thorough understanding of a part without a general knowledge of the whole. The high schools can not train chemists or engineers. Time and cost do not admit of such intensive science teaching, even if it is desirable. Such teaching should be left to the college.

If we take the pupils as we find them in our large city high schools they are not well informed and have little opportunity to be. They live in a complex environment. The city boy or girl is brought in contact with but few simple phenomena; a push of a button—a bell is rung; another push—a door is unlocked; another push—a light appears. The modern apartment is a complicated structure operated by buttons. If we look for chemical actions within this pupil's sphere we find them to be rather few, too familiar to hold the attention or too complicated to tempt analysis. He comes in contact with but few elements and but few pure compounds. Steel is to him a specially pure iron, zinc is the metal used in batteries, tin—used for cans, sulphur smells bad. He has often been told that soda water contains no soda. Soap is useful in cleaning, as it eats dirt as an acid "eats metals." A material involving electric means is necessarily superior.

The tendency to centralization in driving out small industrial establishments has narrowed the child's opportunities for observation. The shops of the blacksmith, carpenter and soap-maker where he learned the art of critical observation and learned some things not taught in school, have been withdrawn behind doors marked "no admission."

The classes of our large schools are mixed as to sex, race and ability. It is often said with pride that our urban population is cosmopolitan, but that the second generation from the emigrant is acquainted with American ways. Admitting that the second generation may be somewhat acquainted with American ways, we must also admit that the population of our large cities is becoming mongrel. The mongrel is never stable and is rarely successful. The psychology of the mongrel is analogous to that of the mob. Is it not then asking too much that children one or two generations from barbarity should be put through the same course and be expected to meet the same educational standards as the natives of Massachusetts?

The tendency of education at present is the development of *power*, of ability to reason, to think. We may, indeed, ask if the drill along this line has not been pushed so far at times as to neglect giving something to think about. The school, unlike the college, works by the clock, the work must be cut to fit the time, thus we often find a few facts or questions are presented in such a way that but one conclusion is possible. This is called inductive teaching—teaching to reason.

It makes the work easier for the teacher

if the work can be made to follow a mathematical model, so problems come to take an important place. The work becomes quantitative and is now held to develop thought, originality and logical reasoning. But the problem in elementary chemistry is usually of type form, and is not the teacher largely sponging on the power drilled into the pupil by the mathematics teacher? The English of the schools is criticized by college and business men alike. I believe a clear, concise exposition of phenomena in correct language will be of more benefit to the pupil than any number of problems in chemical arithmetic.

The pupils I have in mind are the ordinary ones in large schools, thirteen to sixteen years of age, girls and boys. Only a small percentage will go to college, some will go to business, some to be clerks, some home makers, some teachers. They have been herded in elementary schools, taught *at* in bulk. They are deficient in English and any correct notions of the activities of the world. It is the business of the high school to supplement the elementary school and by its specialization correct the errors of the grades and systematize the instruction. College preparation is only incidental.

A large amount of knowledge is not needed in practical life so much as the power to do things, but knowledge certainly increases power. While we must be able to do one thing well even a superficial knowledge of many things is not to be despised. Good judgment, ability to arrive at accurate conclusions from given data is most essential, but if we look closely a large part of what is commonly called reasoning is but rehearsing of formulæ. Good judgment can not be taught. So few of our pupils will ever be so situated that they need reason independently concerning chemical phenomena that it is scarcely justifiable to foist the time and cost of such instruction on the public.

Where and how can chemistry accomplish the most good in the school? If the object of education is to develop a youth most completely, to make a well-rounded individual, to make him feel an intelligent interest in the activities of the world, it is not necessary that each factor in such a total should be well rounded. A number of smooth, well-rounded sticks will make a very insecure bundle, but if some of the sticks are somewhat rough the bundle may not appear so elegant but it will be more firm. Chemistry touches every phase of human activity. It requires language for its expression, mathematics for its determination, physics for its operation. Its history is the history of the world.

It would be impossible to find a better subject than chemistry to bind together the school work, to systematically furnish splinters to make the bundle strong. The domestic science teacher, the biology teacher and the physics teacher give some splinters of information which they call chemistry and build their work upon this basis, usually indigestible definitions. A systematic course in elementary science should be placed in the first year of the high school, designed to impart that information of things and processes we might well expect every one to know. This might be followed later by a course more thorough.

We now expect our pupils to specialize as soon as they leave the elementary schools and to prepare for some life work. He or she knows nothing of human activities out in the everyday world, there is practically no place in the school curriculum where this is taught. We have trade schools, vocation schools, commercial schools, not to mention others all of which require him to specialize before showing

him any general plan from which to choose or guiding his choice.

The pupil who will receive no further school instruction can in a year be given a good knowledge, by a teacher with adequate equipment, of many of the facts of elementary chemistry relating to our daily life and its activities—a knowledge sufficient in most cases to excite a lasting interest in natural phenomena and to cause the student to seek explanation. There is a multitude of chemical facts which concern the boy who goes into the shop or office or behind the counter, and which he should know. The girl who will stop at home or teaches others' children is also concerned with chemical phenomena. chemical information which has been crowded out of her curriculum to make room for more cultured and less mussy subjects.

Adhering to traditional procedure, our science courses have become pseudotheoretical or pseudotechnical; it is time we had one systematically informational and practical. Facts are as important as explanations and should precede them. Such a course need not pretend completeness in any line. It might be comparative rather than critical. It would not attempt to rediscover or verify natural laws, but would aim to cultivate the powers of observation and of accuracy of description, to express ideas of phenomena in simple, direct English rather than to hide incoherent thought behind a big name or a slang expression.

In a first course in chemistry, atoms, molecules, ions and many other terms might be omitted altogether. They are but words, the modern idea of an atom is incomprehensible to one without a wide knowledge of chemistry. Theory should be eliminated as much as possible, making the course treat of facts, their sequence and relation to one another. Numerical problem solving should take but a small part in recitation work. No more can come out of an equation than we put into it. It can not develop originality.

Such a course for children of twelve to thirteen years would need simplicity in its treatment. Faraday's lectures to children are a model in this respect. Ostwald's "Conversations" show how some complicated things may be dealt with simply.

I would have such a course give information concerning natural phenomena and the work of man, show what is being done, and how, without technical detail.

I would give the pupil something to *know*. Facts that are worth knowing in and of themselves—facts that concern himself, his food, his clothing, his shelter and his work. Concerning the things he or she will meet in life, no matter whether the future be as a chemist, a bookkeeper or in the kitchen. The material is ample.

The subject might be systematized by its applications rather than the traditional order. Study topics rather than elements; study detergents, not soap; study bleaching rather than peroxide or bleaching powder. The development of the race through the stone, bronze and iron age has depended largely upon his chemical knowledge. Let us study the metals in their metallic aspects rather than according to the periodic table.

Foods, clothing, materials of utility and convenience or of commerce often can not be rationally treated by the present systems of our texts, but a suitable systematization might easily include these; what they are, how they are produced and what they do.

In its effects upon the pupil and school, we may be sure that pupils who have seen something of the general trend of the instruction through a systematic preliminary

course will feel more interest to continue study and will accomplish more and better work in later courses.

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THE AMERICAN MEDICAL ASSOCIATION[1]

THE St. Louis session of the American Medical Association was an unqualified success. From the scientific point of view, and from the effect in the promotion of a closer and more harmonious organization of the profession, as well as of social interest, little more could have been desired. The registration was a little over four thousand, a number exceeded only twice—at Boston and at Chicago.

In the scientific interest and in the earnestness and fulness of the discussions on the topics presented the section meetings equaled or surpassed those of any previous session. Every section had profitable meetings and the attendance in each was good. Especially notable were the symposiums in the Section on Preventive Medicine and Public Health on hookworm, pellagra and typhoid fever, and in the Section on Pathology and Physiology on cancer—subjects which, aside from their interest to the profession, have particular interest for the public, because of the wide-spread morbidity and mortality which they cause, especially in the instances of typhoid fever and cancer. Indeed, it is interesting to note the many points at which the papers throughout the whole program of this session touched the public directly in the matter of hygiene, sanitation and prevention. It is a reflection of the wide-spread interest of the public in what is being done in medicine. In many respects the Section on Preventive Medicine was the most interesting of the session. Cancer, with its frightful mortality and increasing prevalence, was probably the most prominent subject of the session, being considered in one or more of its aspects in almost every section, far outshadowing tuberculosis in this respect. In some of the other sections symposiums on diabetes, the infectious diseases and eclampsia, with the discussions, served to clear the atmosphere about many mooted questions. There were many other interesting features of the scientific program, but space forbids further mention of them here.

[1] From the *Journal* of the Association.

The meetings of the house of delegates were harmonious throughout. Each succeeding year the reference committees are doing more and more work, making it possible to investigate thoroughly all the various propositions that come before the house; and thus the house is able to accomplish much more, and to do the work in a deliberate, satisfactory manner. Of the important things done by the house of delegates, one was the creation of a new Section on Genito-urinary Diseases, as petitioned for by many members doing work in that line. Another was the creation of the Council on Health and Public Instruction, which is to have charge of the work formerly done by several overlapping committees, covering such matters as preventive medicine, medical legislation, economics, public instruction in medical, sanitary and hygienic questions, etc. The council will organize complete machinery to facilitate the attainment of these objects.

Any impression that there was the slightest lack of harmony in the organization was dispelled by the work of the house of delegates and by the spirit shown in the daily work; and any attempted disparagement of the aims and purposes of the American Medical Association was silenced by the splendid statement of them contained in the address of President Welch at the general meeting. That the public correctly understands these aims and endorses them was evinced in the admirable address of Governor Hadley and the other gentlemen who spoke at the general meeting.

THE ASTRONOMICAL OBSERVATORY OF DENISON UNIVERSITY

AT Denison University, Granville, Ohio, the new astronomical observatory, presented by Mr. Ambrose Swasey, of Cleveland, was opened

on June 15. In the afternoon an address on "The Contribution of Astronomy to General Culture" was given by Edwin B. Frost, of the Yerkes Observatory, and in the evening an illustrated lecture on "The Revelations of the Telescope" was delivered by John A. Brashear, of Pittsburgh.

The observatory is a very beautiful structure of white marble, and its interior finish is in excellent harmony with the elegant exterior. The principal instrument is a nine-inch telescope, with object-glass by the J. A. Brashear Company, with the latest style of mounting by Warner & Swasey, complete in every detail, and with a filar micrometer by the same firm, of which the donor is vice-president. A fine four-inch combined transit and zenith-telescope is also provided, together with a chronograph, all by the same makers. The equipment also includes two Riefler clocks, for mean and for sidereal time, and a sidereal clock for the dome. The observatory is very well situated upon a high ridge commanding the horizon, and is admirably adapted for its purpose, principally educational, but the equipment is also sufficient for useful contributions to research.

SCIENTIFIC NOTES AND NEWS

The Paris Academy of Sciences has conferred the Janssen Prize, consisting of a gold medal, on Director W. W. Campbell, of the Lick Observatory, University of California.

Dr. John Benjamin Murphy, professor of surgery in Northwestern University, has been elected president of the American Medical Association, for the meeting to be held next year at Los Angeles.

The University of Pittsburgh has conferred the doctorate of science on Professor H. L. Fairchild, professor of geology in the University of Rochester.

Dr. Oscar Bolza, professor of mathematics in the University of Chicago since its establishment eighteen years ago, has been made non-resident professor, and will live in Freiburg, Germany. He will receive his regular salary.

We learn from the *Journal* of the American Medical Association that a bronze relief portrait of Dr. William Osler has been placed in Osler Hall of the Medical and Chirurgical Faculty, Baltimore. It is by F. C. V. de Vernon, a French sculptor, and is an enlargement of a small one made in 1903 by the same artist and now in the Johns Hopkins Medical Library. It will be placed by the side of the Osler portrait by Corner on the north wall, and on the other side will be hung the Welch medallion.

After nearly continuous service of nine years in the American Museum of Natural History, Director Hermon C. Bumpus has been granted a vacation by the trustees, beginning June 15. Dr. Charles H. Townsend, director of the New York Aquarium, has been released from his duties for the same period and has been appointed acting director of the museum during the absence of Director Bumpus, which will probably extend to December 15, 1910. Professor Raymond C. Osburn, Ph.D. (Columbia), of the Biological Department of Barnard College, has been recalled from Naples to take charge of the aquarium, during the same period, under Director Townsend's general supervision. It is the intention of the Zoological Society to make Professor Osburn a permanent member of the aquarium staff.

Dr. Harvey W. Cushing, of the Johns Hopkins University, has been appointed chief of the surgical staff of the new Peter Bent Brigham Hospital at Cambridge, Mass. The hospital, which is the teaching hospital of the Harvard Medical School, will not be completed until about 1912. The fund has been accumulating for about twenty-five years and the original bequest of $1,800,000 has grown to about $8,000,000.

Professor H. A. Edson, of the University of Vermont, has resigned, to accept a position in the Bureau of Plant Industry, Washington, D. C.

Dr. Theodore Whittelsey has resigned as associate professor of chemistry in Northwestern University to become chief chemist of the

Rubber Regenerating Co. His address is Mishawaka, Ind.

DR. CHAS. W. HARGITT, professor of zoology in Syracuse University and director of the zoological laboratories, has been granted leave of absence for the coming year, and will devote his attention to research at several American and European laboratories.

PROFESSOR ROBERT H. RICHARDS, of the Massachusetts Institute of Technology, left on June 10 for summer school work with his mining students. He was accompanied by Professor Bugbee and Instructor Hayward. The party go to Buffalo, and from there take an ore steamer to Duluth, where they will see the ore docks. They expect to visit the Michigan copper region at Keweenaw Point, the nickel mines at Sudbury, Ontario, and the silver mines at Cobalt, Ontario.

THE collection of fresh-water sponges of the U. S. National Museum is now being critically examined by Dr. Nelson Annandale, superintendent of the Indian Museum in Calcutta, an authority on this subject.

M. DARBOUX, permanent secretary of the Paris Academy of Sciences, has been elected president of the Société de secours des Amis des Sciences.

PROFESSOR J. C. EWART, F.R.S., of Edinburgh, will give a course of lectures on the principles of breeding, at the Graduate School of Agriculture to be held at Ames, Ia., in July.

A BUST of Pasteur was unveiled on June 5 in the garden of the Ecole Normale Supérieure, Paris, where was his first laboratory and where he taught for thirty-seven years.

IN memory of the late Dr. Howard T. Ricketts, of the University of Chicago, who recently died in Mexico of typhus fever while investigating the disease, there has been established in Rush Medical College, of the university, a prize of the value of $25 to be awarded annually to the student presenting the best thesis embodying the results of original investigation on some topic relating to dermatology. The prize will be known as the "Howard T. Ricketts Prize."

DR. WILLIAM HENRY SEAMAN, examiner in the U. S. Patent Office and professor of chemistry in Howard University, died on June 12, at the age of seventy-three years.

THERE will be a New York State Civil Service Examination on June 25, for the position of civil engineer, at a salary of $2,224, and of chemist in the Department of Agriculture, at a salary of $900 to $1,200.

ELABORATE plans for the enlargement of the New York Aquarium are now being prepared by the Zoological Society, under the supervision of Director Townsend, by Mr. J. Stewart Barney, architect. The plans involve greatly improved architectural effect and will treble the present capacity of the aquarium. The institution is by far the most popular of its kind in the world. The attendance, under the administration of the Zoological Society, has increased very rapidly. This year it will probably equal, if not exceed, four and a half millions.

PLANS for the extension of the American Museum of Natural History are now being prepared by the trustees, and designs for the new west entrance pavilion and transept on Ninth Avenue will soon be submitted to the commissioner of parks. The committee on building and plans is also at work upon designs for the completion of the entire south half of the great museum of the future. The present building, erected between 1874 and 1908, includes eight units, that is, the south transept (the original building), the south entrance pavilion (the second building), three façade wings (two on the south and one on the west) and two corner pavilions, completing the south façade. The plans now in preparation contemplate the addition of six units more, which will complete the central hall and east and west transepts, the east entrance pavilion and the southeast façade.

WE learn from *Nature* that the valuable collections of native African art made by Mr. E. Torday in the southern Belgian Congo are now being classified and arranged by the authorities of the British Museum. The most

tion than that which exists at present can hardly fail to result, even though the degree of recognition of secondary school instruction may fall short of that which some desire.

H. P. TALBOT
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

HIGH SCHOOL CHEMISTRY: THE CONTENT OF THE COURSE[1]

EVERY teacher in the high school of today finds himself in stimulating circumstances. He is obliged to question himself closely as to the part that his subject plays in the curriculum, for, at least in the large cities, the long-discussed change in the character of the high school is upon us. The reason for the change is found in a realization of the facts that in the past, high school education has been enormously wasteful; that eighty to ninety per cent. of our pupils do not complete the course; that only a small part of the remaining per cent. achieve the purpose for which the whole course has been framed, that of entering college. The evidence that the change has actually begun is found in the establishment of trade and vocational schools, in the frequent discussion of questions pertinent to these points, and in the statements of principals and superintendents that something must be done to stop the enormous educational waste; and in their declaration that the high school must meet real needs, must give the boy or girl the education that is best for him or her, as a member of the human group, with little reference to college entrance.

Among the changes that are coming from a recognition of these facts, we find the importance of science in the high school largely increased. The fact that it is science that has produced the great material advance of the past century makes it certain that in the further turning from formal to practical education, science will play a larger part. It is the purpose of this paper to inquire into the manner in which these changing conditions are reacting on the high school course in chemistry, and to discuss some of the considerations that are determining, or should determine, a new course of study. The speaker wishes also to discuss, in general, the problem of high school chemistry, presenting personal and perhaps even extreme points of view.

We may classify the various forces that are shaping the new course as external and internal. In the first class we find: (*a*) a lessening of the college influence, due to a realization of the necessity of educating for other purposes than college entrance; (*b*) a tendency to put chemistry earlier in the course and to give a second year of it; (*c*) what we may call the lay demand for practical education.

The lessened college influence will give to the body of secondary teachers not only greater freedom in the selection and arrangement of their material, but what is of even more importance, because it serves as a stimulus to their creative ability, a realization of the importance of their own great work and their responsibility for it. The lack of this kind of freedom is in part responsible for the condition that exists to-day when the high school, paying comparatively high salaries, can not get enough good men, while the college apparently has more than it needs at a smaller compensation. This is not the least of the evils that have resulted from the college domination of the high school. Others have often been pointed out and are well known. The course of study can never be adapted to the real needs of the high school so long as it is framed by the

[1] Presented at the second decennial celebration of Clark University, Worcester, Mass., September 16, 1909.

college, at the best a force operating at a distance, at the worst a power acting for needs it can not know. The college, as far as the high school was concerned, always had the idea of preparation, not growth, in mind. A thousand boys went through a course in chemistry whose nature was determined solely by the needs of the three or four who were to be trained to be expert chemists. It is often said at this point that the course which best prepares the pupil for advanced work is also best for every other boy. It is nearer the truth to say that the education which best meets the needs of the growing member of the human whole ought to be the best preparation for college.

Chemistry earlier in the course and perhaps a second year of it; the first of these conditions may bring dismay to many teachers; the second, delight to all, surely. Certainly some changes in the traditional course are necessary in teaching chemistry in the second year. On this point the speaker can refer to an experience covering nearly seven years. During all that time chemistry has been taught to some second-year students. At times fourth-year students and second-year students have been taking nearly the same course simultaneously in separate classes; at other times the two terms of students have been mixed in the same class. In both cases a certain degree of success with the second-year students has been obtained, even if we judge by no other standards than results of college entrance and state board examinations. Speaking for the moment from the standpoint of the college entrance syllabus, but little change is necessary to adapt the chemistry to second-year students. A less rigorous insistence on the philosophical development of the atomic and other hypotheses seems to be the most necessary item of change. In any case, as far as the ability of the student to comprehend is concerned, the difference between individuals is much greater than the difference between second- and fourth-year classes. The general average of work is considerably better in fourth-year classes, but this is explained largely by the dropping out of weak material.

To meet the demand for practical education, we find that there is a decided tendency to introduce into the high school a great deal more of chemical technology than there was in the older course. There are some who go so far as to say that the high school ought to give the pupil a means of earning his living; that chemistry should be taught so as to fit him for some direct employment in practical occupations. While admitting this as a possible ideal, the view implies such an extreme change in the character of the high school that it is not advisable to take it into consideration in the present discussion, except to admit that, given time, it would be possible to accomplish this result. Along with the demand for technical education, we find a tendency to fill the course with a great deal of matter that is associated with the home and every-day life. These two demands have come largely from without. They have done great good and have added much to the human interest of our science. We teachers are very prone to an academic point of view, and the stimulus has been a needed one. Yet with the good, there is some danger. There is a tendency in some quarters to emphasize the technological details of processes, to fill the discussion with technical terms, so that the pupils' talk bristles with tuyères and downcomers and the particular names of the many towers that find application in manufacturing chemistry. The chief evil of this kind of instruction is that it produces rather showy results, it seems to indicate more knowledge

$15^h 15^m$, Pac. St. time, on the night of September 1, 1909, and after the first observation the relative humidity was found not to exceed 4 per cent., the vapor tension not to exceed 0.15 millimeter at any of these readings.

My statement quoted in Lowell Observatory Supplement refers to the weather in general during our stay on Mt. Whitney, but referring to the weather on September 1 and 2, Professor Campbell states: "No clouds were visible in any part of the sky on either night. There had been a few clouds in the afternoons, but these cleared away completely at sunset. There were no clouds in the forenoon of September 3. We can not doubt the evidence of the clouds and the instruments that considerable moisture existed in the afternoons and early evenings, and that later in the evenings the vapor contents of the air were reduced to a remarkably low quantity."

I was present, and saw all the spectra, and can confirm Professor Campbell's description of them, and also his statement of the apparent condition of the sky during his observations. I also verified the excellence of definition of his spectroscope. If, as stated in the Lowell Observatory Supplement above referred to, "The excessive moisture must have pervaded the air generally to the masking of moisture on Mars," it could not, in my judgment, have failed to have produced a little *a* band of more noticeable strength both for Mars and the moon in spectrograms No. 1 and No. 2.

As of course you would not wish me to be placed by a bulletin of the Lowell Observatory in what I regard as a false light, I venture to hope you will do me the great favor to publish this letter completely.

By authority of the secretary:

Very respectfully yours,

C. G. Abbot,

Director, Astrophysical Observatory

Director Percival Lowell,
Lowell Observatory,
Flagstaff, Arizona.

53 State Street, Boston,
16 May, 1910.

Dear Sir: On my return from Europe to-day I find your note of March the twenty-fourth.

I am very sorry that you should feel hurt by a quotation of your own words, nor does it seem to me that your letter changes them in the least, and as to publishing the letters it receives, this is never done by the observatory.

Believe me to be,

Yours truly,

Percival Lowell,

Director

Professor C. G. Abbot,
Director, Astrophysical Observatory,
Washington, D. C.

BACTERIA IN THE TROPICS

To the Editor of Science: Allow me to correct a statement made on page 618 in no. 799 of Science. It reads: "As a matter of fact, the ordinary bacteria of northern latitudes do not flourish in the tropics."

During the summers of 1907 and 1909 I had ample occasion, as physiologist of the U. S. Experiment Station in Mayaguez, Porto Rico, to examine soils in this tropical island. I found that the most common soil microbes of the north occur also there. *Bacillus mycoides* takes here as there the most prominent position, then follows *Bacillus subtilis* and *Bacillus butyricus* (*Clostridium*) and then *B. fluorescens liquefaciens*. *Azotobacter* is found everywhere on the surface in great abundance. A superabundance of microbes in these tropical soils is checked by a very rich infusorial life. Infusoria, Flagellata and Amœbæ devour continuously great numbers of microbes. The nitrogen content of the superficial soil-layers is doubtless due to a considerable extent to the dead and living bodies of these low animals.

Oscar Loew

QUOTATIONS

THE SALARIES OF PROFESSORS

While the universities of the land are receiving the most munificent gifts, while millions are devoted to the construction of marble halls and ivory towers, the wives of the college professors are trying to make both ends meet on their husbands' average salary of $2,500 a year. The size of some professors' families fails to support the theory of race suicide, but their stipends for training the youth of this great and wealthy country afford a pretty clear demonstration of the be-

ginnings of race homicide among the more cultivated members of the race. College professors must be presentable socially and as befits their learned station. They have not the means to rear their families.

If the plight of the professors is evil, that of the assistant professors is worse. Consultation of Bradstreet's tables shows that the cost of living has increased 50 per cent. during the period in which the assistant professor must serve before being promoted. The young men who choose a career in a university must, of course, and gladly do, abandon expectation of riches. But they should be permitted to live, not merely to exist, on a wage that is exceeded by the bricklayer's. After a general and specific investigation Professor Guido H. Marx, of Stanford University, recently reported in SCIENCE that assistant professors have found their salaries inadequate to support them comfortably as celibates, and many are seriously debating whether to resign their positions.

There is something unsound in university administration when the faculties are so ill-paid. Possibly competition with the state universities, which are steadily voting percentage increases of salary to their faculties, will stir the majority of privately endowed institutions to action. But their trustees have been too long asleep.—N. Y. *Times*.

SCIENTIFIC BOOKS

National Antarctic Expedition, 1901–1904. Natural History, Vol. V. London, British Museum, 1910. Seal Embryos, by Dr. H. W. MARRETT-TIMS. 21 pp., 2 pl. Tunicata, by Professor W. A. HERDMAN. 26 pp., 7 pl. Isopoda, by T. V. HODSON. 77 pp., 10 pl. Nemertinea, by Professor L. JOUBIN. 15 pp., 1 pl. Medusæ, by E. T. BROWNE. 62 pp., 7 pl. Lichenes, by Dr. O. V. DARBISHIRE. 11 pp., 1 pl., 4to.

The fifth volume of the reports on the Natural History of Captain Scott's expedition to the Antarctic edited by Mr. Jeffrey Bell has now appeared and the preface states that another volume will probably conclude this series of reports which has contained so much of value and so many additions to our knowledge of the Antarctic region.

The seal embryos all belonged to Weddell's seal and from the data accompanying them it seems that the period of gestation is about nine months, the young being born in October or November. They are covered at birth with a coating of hair which is shed during the first month. After the second coat appears the young seal may take to the water, though it is not weaned until some time later. The vibrissæ precede the body hair in appearance and were distinctly visible in an embryo four inches long. In a very early embryo what is regarded as a trace of an external ear was detected. The examination of the muscular system seemed to lend some additional support to Mivart's suggestion of a Lutrine origin for the Phocidæ.

The collection of Tunicata contained twenty-two species; excluding the pelagic forms there are thirty-three specimens belonging to fourteen species.

The Antarctic tunicate fauna is characterized by the abundance and large size of the individuals of a comparatively few species. Our knowledge of the fauna is still too limited to allow of a critical comparison with that of the Arctic, but a certain similarity of families and genera is noticeable. The strictly Antarctic region, south of latitude 60° S. has already furnished some fifty species of Tunicata, of which Professor Herdman gives a list. Ten new species are described, of which one is probably the largest *Styela* known.

No less than twenty-five species of isopods were captured. Remarkable sexual variation was noted among the Arcturidæ. An interesting feature, first pointed out by Miss Richardson, is the presence of long peduncles supporting the eyes; these have now been observed in seven Antarctic species. Mr. Hodson gives a list of the known isopods of the Antarctic region of which twenty-nine out of one hundred and eleven are strictly Antarctic, seven are also found in the Arctic regions, and the remainder belong to the subantarctic region.

The recent Antarctic explorations have produced a fair number of new Medusæ, many of which have well-marked and interesting specific characters, but there are only about three new genera. Probably, according to Dr. Browne, none of them will remain peculiar to the Antarctic when the ocean has been more thoroughly explored. The littoral Hydromedusæ of the Antarctic have not yet been found in the Magellanic, South Australian and New Zealand areas; it looks as if they belong to an ancient stock which has long been isolated from the rest of the world by the Great Southern Ocean. As evolution is proceeding more slowly in cold than in warm regions, the characters of an Antarctic medusa should be more primitive than those from a warmer sea. Dr. Browne gives comparisons which in a number of cases seem to sustain this view. Some very large scyphomedusæ are reported, including a *Diplulmaris* with arms twelve feet in length.

The lichen material brought back by the expedition included some twenty-five species and there are recorded from the Antarctic continent and closely adjacent islands some eighty-eight lichens. Of these thirty-eight are confined to the region between 60° and 78° south latitude, as far as known. The southern lichens do not present any new genera and occur in small quantities contrasting with the abundance found in the Arctic regions. Four species were found on the peaks of the Antarctic volcanoes, Mts. Erebus and Terror, and of these three are also inhabitants of the Arctic regions. That any indigenous organized object whatever can exist on these gloomy volcanic peaks covered with and rising out of eternal ice and snow, seems almost miraculous!

The plates of this volume are of the usual high quality, and the whole character of the work is such as would be expected from the authorities of the British Museum.

Wm. H. Dall

Catalogue of the Lepidoptera Phatænæ in the British Museum. Vol. IX., Noctuidæ, 1910.

The present volume completes the account of the subfamily Acronyctinæ of the Noctuidæ. It contains 725 species in 185 genera, showing a total for the subfamily of 2,288 species in 385 genera. The volumes of this series are appearing with gratifying rapidity. We have only recently noticed the publication of volume VIII. The present volume is on a par with its predecessors in general plan and execution. The table of genera for the subfamily is again repeated with final additions and corrections and will now become fully available.

Harrison G. Dyar

U. S. National Museum,
Washington, D. C.

SPECIAL ARTICLES

ON THE SPECTRUM OF MARS AS PHOTOGRAPHED WITH HIGH DISPERSION [1]

Let us recall that the solar spectrum, as viewed by terrestrial observers, is composite. Photospheric light, in passing out through the gases and vapors of the sun's atmosphere, is selectively absorbed, with the result that many thousands of lines are introduced into the spectrum. The transmitted light passes down through the earth's atmosphere to the observer, and the absorption by water vapor and oxygen in the terrestrial atmosphere introduces many hundreds of additional lines, at definite points in the yellow, orange and red regions. The observed spectrum of the sun is in reality the spectrum of the sun plus the spectrum of the earth. The spectrum of the moon, so far as our present problem is concerned, is simply this sun-earth spectrum.

The light from Mars is photospheric light, which passes out through the sun's atmosphere, thence down through the atmosphere of Mars to the planet's crust, where a certain proportion is reflected out through the Martian atmosphere, and thence down through the earth's atmosphere to the observer. The so-called spectrum of Mars is in reality the sun's spectrum plus Mars's spectrum plus the earth's spectrum.[2] Any water vapor and

[1] Read at the April, 1910, meeting of the National Academy of Sciences.

[2] A little of the light would be reflected from the atmospheric strata of various heights without.

oxygen in the Martian atmosphere should introduce the same absorption lines which are introduced by the earth's atmosphere in the sun-earth spectrum.

If the distance between Mars and the earth is not changing rapidly, the water vapor and oxygen lines from Mars and the lines from the earth will coincide. When this condition of coincidence exists, it is clearly a difficult problem to detect moderate quantities of water vapor and oxygen in the Martian atmosphere, for the evidence of Martian absorption will be overwhelmed by the absorption of the richly laden terrestrial atmosphere, especially if the observer be near sea level. To hope for success, the observations should be made from a high-altitude station, at times when the overlying air strata carry a minimum of water vapor, and when the planet is as near the zenith as practicable; observing the lunar spectrum, under identical conditions, for comparison.

Because of the faintness of the Martian and lunar spectra, it has been found that we are limited to low dispersion in visual observations: and that when the distance between the two planets is constant or nearly so, low dispersion offers a more sensitive method than high dispersion, even when photography is employed.

Complying with the conditions in the two preceding paragraphs, the writers photographed the spectra of Mars and the moon last September, from the summit of Mt. Whitney. The conclusion drawn from that investigation was, in brief, that the quantity of any water vapor then existing in the equatorial atmosphere of Mars was too small to be detected by the spectrographic methods available. This does not mean that the Martian atmosphere was carrying no water vapor, but only that the quantity must have been very small.

At times other than those when Mars is near opposition, the earth and Mars are relatively approaching or receding from one another. Their relative velocity at quadrature may amount to 20 km., more or less, per second, depending upon the concurrence of favorable circumstances.

When Mr. Campbell was photographing the spectrum of Mars, in December, 1896, with a Rowland grating, fourth order,[3] 568 lines per mm. (14,438 per inch), he realized that the Doppler-Fizeau principle offers great advantages, in theory, for solving the problem of the Martian atmosphere, for on photographs of the spectrum, made near quadrature, with sufficiently high dispersion, the Martian absorption lines and the terrestrial absorption lines should be separated. At that time (thirteen years ago) the method could not succeed, for all the prominent water vapor and oxygen lines are in the region on the red side of λ 5875, and the photographic dry plates then available were not sufficiently sensitive to record this region. Even in the fairly sensitive region λ 5700–λ5800 the grating spectrograms of Mars were underexposed. The successes of recent years in sensitizing dry plates to yellow, orange and red light have encouraged the present effort to apply the method.

A spectrograph, designed by Mr. Campbell to meet the requirements of the problem and used in connection with the 36-inch refractor, contains an excellent Michelson five-inch plane grating (15,000 lines per inch) which gives a brilliant spectrum in the second order on one side, and this was utilized. The wooden mounting of the spectrograph was designed at all points to resist differential flexure during the intervals of exposure to the planet and to the moon. The instrument was adjusted, the observations were secured, and the measures and reductions of the spectrograms were all made by Mr. Albrecht.

It was planned to secure observations of Mars and the moon on or near January 17, 1910, as the planet was in quadrature at that time. The spectrographic velocity of Mars with reference to the earth was then 18.8 km. per second, recession. Unfavorable weather

passing down to the planet's surface. On the other hand, the rays did not, on the present occasion, pass through the planet's atmosphere at right angles to the strata, but the average angle of incidence and reflexion was about 20°.

[3] *Astrophysical Journal*, 5, 236, 1897.

delayed somewhat the carrying out of the program, but fortunately the velocity remained nearly constant for several weeks, until satisfactory observations were secured.

With the spectrograph adjusted for the orange region, which is rich in water vapor absorption, spectrograms of Mars were secured on January 26 and 27 under poor atmospheric conditions, and on February 2 under excellent conditions, our atmosphere on this night being exceedingly dry. Measures of the available water vapor lines on these spectrograms, 8 to 22 in number, establish that they were displaced with reference to the lines of solar origin in the observed Martian spectrum by amounts on the three dates corresponding to velocities in the line of sight of 19.7, 20.2 and 18.3 km. per second; weighted mean value, 19.2 km. The relative velocities of Mars, computed from our knowledge of the orbits of the earth and Mars, amounted to 19.1 km. per second. The dispersion and slit-width employed were such that the water vapor lines originating in our atmosphere and any originating in Mars's atmosphere should have appeared side by side, though not clearly separated. If the absorptions by the two planets were equal, the two sets of lines of equal intensities should, in effect, have appeared as broad lines of double width, and the measured velocities should have been but half the computed velocities. The facts are that the terrestrial lines were not bordered nor increased in width by companion lines. When the micrometer wire was set successively in the positions which Martian absorption lines would occupy, no traces of absorption were found in these positions. In effect, Martian absorption did not exist to such an extent as to be visible in the spectrum, or to influence the measurements referred to.

With the spectrograph adjusted to the so-called "alpha" region at λ 6280, which includes a large number of oxygen absorption lines, two spectrograms were obtained on February 3. The observable oxygen lines, seven and six in number, were displaced with reference to the lines of solar origin by amounts corresponding to velocities in the line of sight of 18.8 and 17.4 km. per second. The velocity computed from the elements of the orbits amounted to 19.1 km. The discrepancy of 1.0 km. is within the unavoidable error of measurement. Here again the terrestrial oxygen lines were not bordered nor doubled in width by Martian lines.

The conclusions to be drawn from this investigation are: The quantity of any water vapor existing above unit area in the equatorial atmosphere of Mars was certainly less than one fifth that existing above Mt. Hamilton under the excellent conditions prevailing on February 2. The air temperature was 0° Centigrade, the relative humidity 33 per cent., the absolute humidity 1.9 grams per cubic meter, and the zenith distance 55°.

Likewise, the quantity of oxygen above unit area of Mars must be small in comparison with that in the earth's atmosphere.

It should be repeated that the rays of light utilized had passed in effect twice through the Martian atmosphere.

W. W. Campbell,
Sebastian Albrecht
Lick Observatory,
University of California,
April, 1910

SOCIETIES AND ACADEMIES

THE AMERICAN PHILOSOPHICAL SOCIETY

At the meeting of the American Philosophical Society, on May 20, the following paper was read:

On the Principle of Relativity and its Significance: Dr. Robert H. Hough, University of Pennsylvania.

The question was considered only in its philosophical aspect. The idea was developed from the fundamental concepts of dynamics as formulated by Newton and Hertz, and extended to the field of electro-dynamics and optics. The validity of the principle as a mathematical concept was maintained. The equations of transformation were derived by purely mathematical steps from two initial equations representing experimental laws to the present probable error of observation: and the consequent relations of the distances and times involved and their respective units considered.